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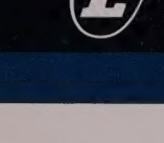
CE-24
FREQUENCY
SELECTIVE
LEVELMETER



CUSHMAN
ELECTRONICS, INC.

CE-24

FREQUENCY SELECTIVE LEVELMETER

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CUSHMAN
ELECTRONICS, INC.

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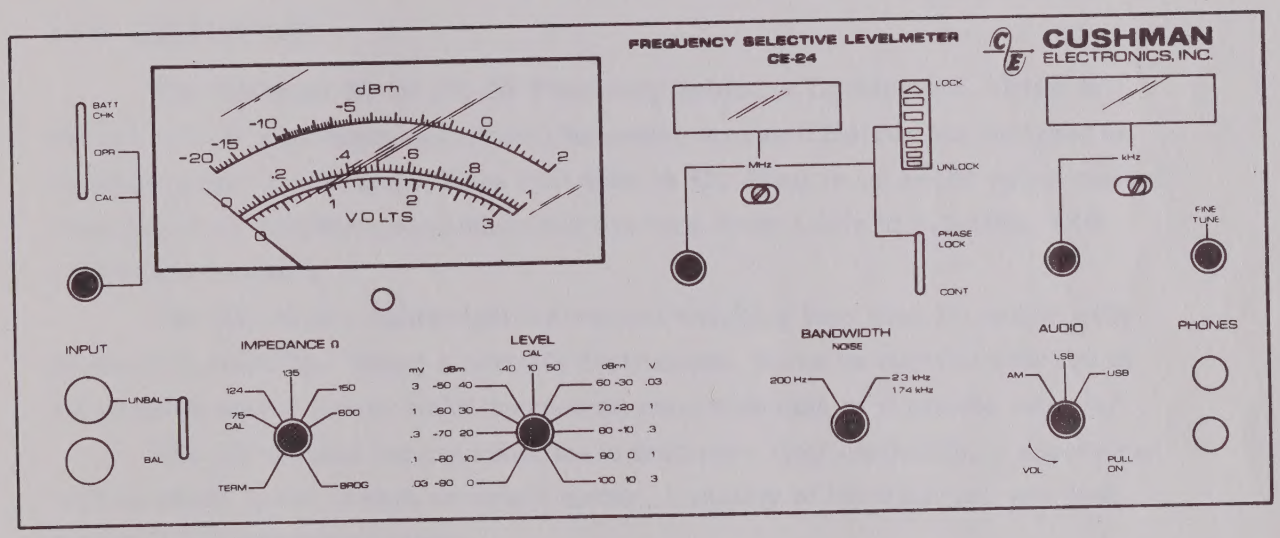


Figure 1-1. CE-24 Frequency Selective Levelmeter

SECTION 1
GENERAL DESCRIPTION

1.01 INTRODUCTION

This section contains general information about the Cushman Model CE-24 Frequency Selective Levelmeter. Included is a general description of the instrument along with information pertaining to purpose and application.

A Table of Specifications is also included in this section of the manual. Refer to Table 1-1.

1.02 DESCRIPTION

The Cushman Model CE-24 Frequency Selective Levelmeter, shown in Figure 1-1, is a portable battery or line power operated instrument designed to measure power levels and voltage (-90 dBm to +10 dBm) in up to 600 voice-channel frequencies of telephone communication systems from 1 kHz to 3.2 MHz, with calibration accuracy.

The CE-24 is a lightweight instrument weighing less than 18 pounds with phase-lock stability. Being a portable instrument, it can be carried with you at all times to enable you to make unexpected measurements at a remote repeater.

The CE-24 also incorporates these features: dual bandwidth, a speaker as well as phone jacks, a high accuracy meter, a variety of impedances, and both balanced and unbalanced inputs.

Also, double sideband transmitted carrier and single-sideband suppressed carrier types of amplitude modulation can be detected and measured. The lower and upper sidebands are detected by reinserted carriers allowing audible monitoring.

1.03 ACCESSORIES

The accessories supplied with the Model CE-24 are listed in Table 1-2.

Table 1-1. Specifications

FREQUENCY

Range ..... 1 kHz to 3.2 MHz
- MHz Oscillator (Phase-locked in 0.1 MHz steps or continuously tuned) ..... 0 to 3.1 MHz
- kHz Oscillator ..... 10 to 100 kHz
- Resolution ..... 500 Hz

Accuracy
- MHz Oscillator (Phase-locked) ..... ±300 Hz
- kHz Oscillator ..... ±700 Hz

LEVEL

Range of Measurement for 0 dBm meter reading ..... -90 dBm to +10 dBm

Range of Measurement for equivalent C message noise reading for 0 dBm meter reading ..... 0 dBrnc to 100 dBrnc

Measurement Error
- 100 kHz @ -40 dBm @ 25°C ±10°C ..... ±0.2 dB
- 100 kHz @ -40 dBm @ 25°C ±25°C ..... ±0.3 dB

Frequency Response, Referred to 100 kHz
75Ω, 124Ω, 135Ω
- 60 kHz to 3.1 MHz ..... ±0.2 dB
- 1 kHz to 3.2 MHz ..... ±0.4 dB

Frequency Response, referred to 100 kHz
600Ω
- 60 kHz to 600 kHz ..... ±0.2 dB
- 1 kHz to 1 MHz ..... ±0.4 dB

Attenuator, Reffered to -40 dBm ..... ±0.3 dB
- +10 dBm, 1 MHz to 3.2 MHz ..... ±0.2 dB

Meter Range ..... -20 dBm to +2 dBm

INPUT IMPEDANCE

Unbalanced ..... 75, 124, 135, 600Ω and 10kΩ shunted by approximately 30 pf

Balanced ..... 75, 124, 135, 150, 600Ω and 20kΩ shunted by approximately 18 pf

INPUT COMMON MODE REJECTION

(Balanced Input) ..... ≥35 dB

BANDWIDTH

Broad
- 3 dB ..... 2.3 kHz
- 60 dB ..... ≤5.2 kHz
- Equivalent Noise ..... 1.74 kHz

Narrow
- 3 dB ..... 200 Hz
- 60 dB ..... ≤800 Hz

Optional Narrowband (In lieu of 200 Hz)
- 3 dB ..... 75 Hz
- 60 dB ..... ≤300 Hz

Table 1-1. Specifications (Continued)

INTERNAL DISTORTION ATTENUATION (75Ω)

Harmonic
For 60 dB sensitivity increase
300 kHz to 3.2 MHz ..... ≥70 dB
For 50 dBm sensitivity increase,
60 kHz to 300 kHz ..... ≥60 dB

Noise Power Ration
(Equivalent 600 channel system with stop band slot@2.438 MHz)
For 30 dB sensitivity increase ..... ≥45 dB

INTERMEDIATE FREQUENCIES

IF 1 ..... 5.55 MHz

IF 2 ..... 455 kHz

IF REJECTION ..... ≥70 dB
IMAGE REJECTION (11.1 MHz to 14.3 MHz) ..... ≥70 dB
OUTPUTS, UNLOADED, METER ON ZERO dB; Nominal

Phones (Phone Jack)
Output Impedance 50Ω
Audio Speaker Power ..... 100 MW

DC Recorder (BNC)
Output Impedance ..... Approx. 1kΩ
Output Voltage, DC ..... 79 MV

OPERATING TEMP. RANGE ..... 0°C to 50°C

STORAGE TEMP. RANGE ..... -40°C to +65°C

POWER REQUIREMENTS

AC Line ..... 115/230V ±10%, 50-400 Hz, 2 Va

Battery (1.2 AH Capacity) ..... 12V, 100 ma Nom.
Operational period without recharging ..... Approx. 12 Hr.
Duration of recharge ..... 10 Hr.

DIMENSIONS ..... 5-1/4 in. H. x 13-7/8 in. W. x 14-7/8 in. D.

WEIGHT ..... Approx. 18 lbs.

Table 1-2. Supplied Accessories

Item	Description	Cushman Part No.	Quantity
1	Extractor, Printed Circuit Board	3875-0036	1
2	Extender, Printed Circuit Board	7001-0079	1
3	Cord, Power	3170-0006	1
4	Assembly, Front Cover	7005-0013	1
5	Manual, Equipment	5601-0024	1

SECTION 2
INSTALLATION

2.01 INTRODUCTION

This section contains information and instructions necessary to prepare for use the Model CE-24 Frequency Selective Levelmeter. Included are unpacking and inspection, power, grounding, and warm-up requirements, as well as installation information and instructions for reshipment packaging.

2.02 UNPACKING AND INSPECTION

When unpacking the CE-24, inspect the packing box and the instrument for signs of possible damage, and see if the accessories listed in Table 1-2 are present. Verify satisfactory performance as outlined in the operating instructions (Section 3) of the equipment manual. If the instrument is damaged, fails to operate properly, or if any of the accessories are missing, file a claim with the transportation agency or, if insured separately, with the insurance company.

2.03 INSTALLATION PROCEDURES

2.03.1 Power Requirements

The CE-24 operates from a 115- or 230-volt (±10%) ac source, 50 to 400 Hz. Power consumption is approximately 17 watts. Two 1/4 amp slo-blo fuses are used to provide circuit protection. One fuse is used during battery operation to protect the battery and the other during line operation.

2.03.2 Battery Hookup and Disconnect Requirements

a. Remove top cover and ensure that instrument power is off.
b. Locate battery and battery storage terminals.
c. Remove orange wire from storage terminal and connect to black terminal (-).
d. Remove black wire from storage terminal and connect to red terminal (+).
e. Replace top cover.

NOTE

To disconnect battery for reshipment reverse the above procedures.

2.03.3 Grounding Requirements

To protect operating personnel, it is recommended that the instrument be grounded externally. To this end the CE-24 is equipped with a three-conductor power cable, which, when plugged into an appropriate receptacle, grounds the instrument. To preserve this protection when operating the instrument from a two-wire outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to ground.

2.03.4 Warm-Up Requirements

There are no warm-up requirements for the CE-24. When the CE-24 is energized by pulling out the AUDIO switch (inner knob), it is ready to operate.

2.03.5 Conversion to Rack Mount

The CE-24 can be mounted in a standard 19-inch equipment rack. The hardware required for converting the CE-24 from cabinet to rack mount is not supplied with the instrument. A Rack-Mounting Kit (P/N 7101-0001-03) is available upon customer request. If the CE-24 is to be converted for rack mounting, proceed as follows:

a. Remove the two screws securing each handle to the instrument.
b. Install the L-shaped brackets with the mounting lip forward using the four #10-32 x 1/2 screws supplied and secure to the handles.
c. Carefully slide the instrument into equipment rack and secure with remaining hardware provided.

2.04 PREPARATION FOR RESHIPMENT

No special instructions are required for packing the CE-24. It is recommended that the shipping box and foam packaging be kept in case it becomes necessary to return the instrument to the factory for service or repair. If further assistance is required, contact Cushman Electronics, Customer Service Department.

The following paragraphs contain a general guide for repackaging of the instrument for shipment.

NOTE

If the instrument is to be shipped to Cushman Electronics for service or repair, attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and part number.

If the original container is to be used, proceed as follows:

a. Place the instrument in the original container. (If the original container is not available, one can be purchased from Cushman Electronics).
b. Ensure that the container is well sealed with strong tape or metal bands.

If the original container is not used, proceed as follows:

a. Wrap the instrument in plastic or heavy paper before placing in an inner container.
b. Place packing material around all sides of the instrument.
c. Place the instrument and inner container in a heavy carton or wood box and seal with strong tape or metal bands.
d. Mark the shipping container with "DELICATE ELECTRONIC INSTRUMENT," "FRAGILE ".

SECTION 3
OPERATION

3.01 INTRODUCTION

This section contains directions to operate the CE-24 with a description of all controls, indicators and external connections.

Before operating the instrument, this section should be read to understand the capabilities and limitations of the instrument.

3.02 CONTROLS, INDICATORS, AND CONNECTORS

Figure 3-1 shows the location of all the front and rear panel controls, indicators, and external connectors. Table 3-1 lists the reference designators, name and functional description of these elements.

3.03 OPERATING INSTRUCTIONS

3.03.1 Line Power Operation

CAUTION

Before operating the CE-24 ensure that the 115/230 AC switch (S3001) located on the rear panel is in the appropriate position.

a. To energize the instrument, plug the power cord into an ac power outlet (115/230-volts, ±10%, 50 to 400 Hz), and turn on the instrument by pulling out the AUDIO control (inner knob) S2006.

NOTE

The battery receives a trickle charge to maintain it in a fully charged state during line power operation, while in the ON position.

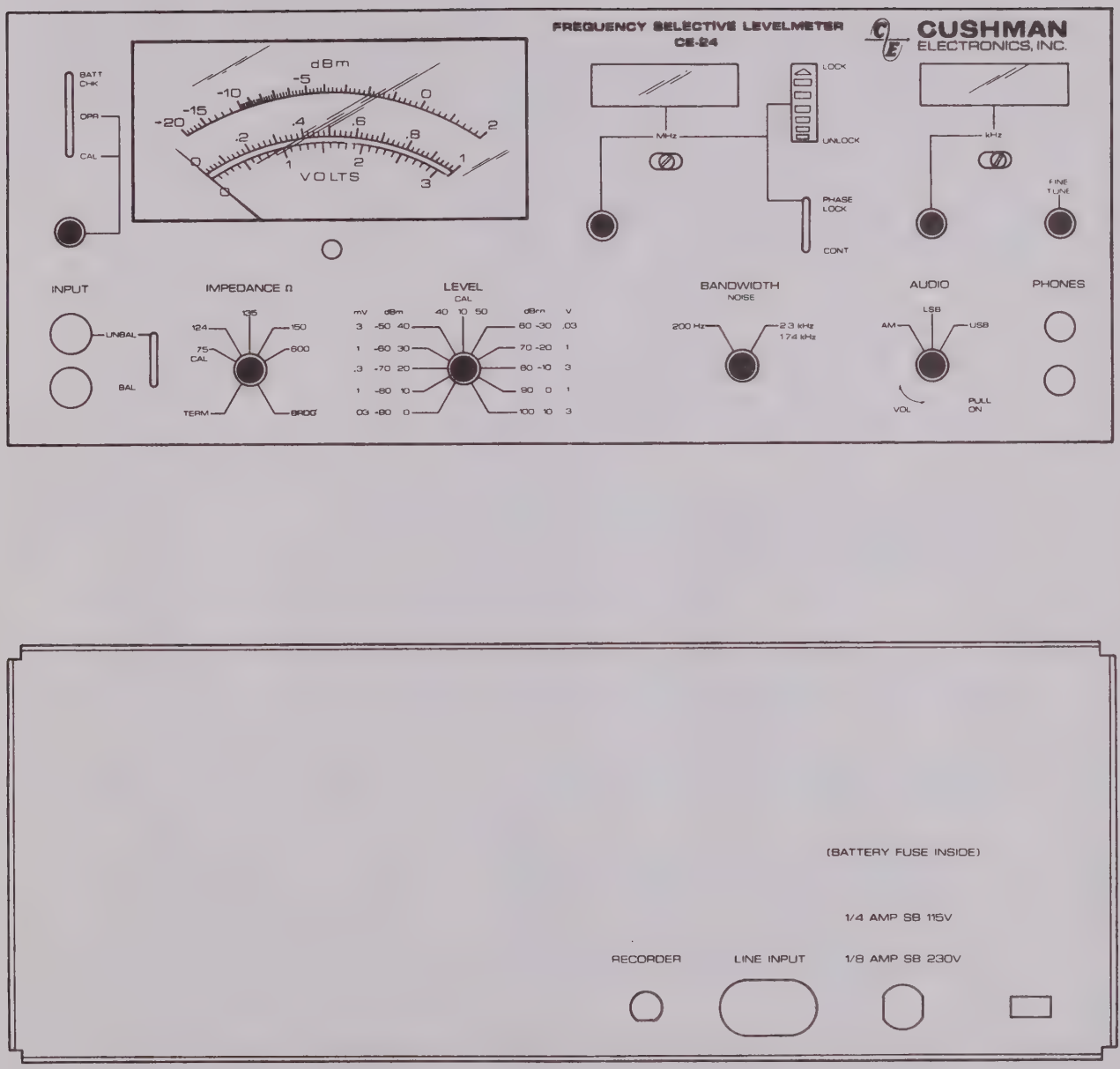


Figure 3-1. CE-24, Front and Rear Panel

Table 3-1. CONTROLS, INDICATORS, AND CONNECTORS

NAME	REF DESIG	FUNCTION
BATT CHK/OPR/CAL	S1001 R1001	A three position lever switch which, in the BATT CHK position, indicates the charge of the battery. In the OPR position it enables normal operation. In the CAL position it connects an internal calibration source (100 kHz) to the instrument, while disconnecting the input signal. The associated potentiometer (R1001) enables adjustment of the gain of the circuits such that the dBm/VOLTS meter reads 0 dBm when the LEVEL switch is in the -40 dBm position.
dBm/VOLTS Meter	M1001	A mirror-backed meter used to indicate the level of a signal of a specific frequency with a resolution of 0.1 dB. The meter face is calibrated (logarithmically) from -20 dB to +2 dB, 0V to 1V, and 0V to 3V.
MHz	C1001	An air capacitor in the tank circuit of the VCO which tunes the 1st LO frequency associated with the dial. The 1st LO frequency can be adjusted in a continuous mode or phase-lock mode of 100 kHz increments.
LOCK/UNLOCK	M1002	A meter indicating the 1st LO is locked to the 100 kHz reference oscillator. Also monitors phase-loop error voltage.
PHASE LOCK/CONT	S1002	A two-position lever switch which enables selection of either a phase-lock or continuous mode of operation.
kHz	C1002	An air capacitor in the tank circuit, which tunes the 2nd LO frequency associated with the dial.
FINE TUNE	R1002	A potentiometer which enables fine tuning of the 2nd LO in a narrow band operation.
INPUT	S1003 J1001 J1002	A two-position lever switch which permits selection of a balanced or unbalanced type input. The two coaxial jacks associated with the switch provide access for balanced inputs; J1001 used singly provides for unbalanced inputs.
IMPEDANCE Ω	S2001 S2002	A concentric rotary switch. The outer knob (S2001) provides termination by the ohm quantity indicated on the front panel. The inner knob permits selection of either a bridging or terminating type input.

Table 3-1. CONTROLS, INDICATORS, AND CONNECTORS (Continued)

NAME	REF DESIG	FUNCTION
LEVEL	S2003	A rotary switch (10-section wafer), which makes up an attenuator with a range of 100 dB attenuation in 10 dB steps.
BANDWIDTH (NOISE)	S2004	A two-position rotary switch which enables selection of the overall bandwidth of the CE-24. When the switch is set in the 2.3 kHz (1.74 kHz Equivalent Noise) position the bandwidth provides the equivalent noise level measurement as C-message weighting filter.
AUDIO	S2005 S2006 R2001	A concentric rotary switch which enables audio information on the carrier of single or double sideband signals to be detected through the appropriate circuits. In the LSB and USB mode the carrier is reinserted to enable detection. The potentiometer, which is coupled with an on/off switch, permits varying the audio level reproduced by the speaker or head phones. The on/off switch applies or removes AC or DC power to the CE-24.
PHONES	J1003 J1004	Twin tip-ring-sleeve jacks which provide access to audio signals for aural monitoring. A standard tip-ring-sleeve plug or a single plug can be used. The speaker is disconnected when either or both jacks are used.
RECORDER OUT	J3001	A BNC-type female connector that provides dc output information for chart recorders.
LINE INPUT	J3002	A recessed three-conductor ac receptacle that accepts an ac power cord for application of power to the instrument.
1/4 AMP SB	F3001	A 1/4 amp slo-blo fuse that provides protection to the instrument for 115V operation. (1/8 amp slo-blo for 230V operation).
115/230 AC	S3001	A slide switch that enables the power supply to operate on either 115V or 230V ac.
DC Fuse	F2001	A 1/4 amp slo-blo fuse that protects the battery from damage due to shorting.

3.03.2 Battery Power Operation

a. Turn on the instrument by pulling out the AUDIO control (inner knob) S2006.

b. Set BATT CHK/OPR/CAL switch to the BATT/CHK position and ensure that dBm/VOLTS meter needle is in the blue area.

c. If the dBm/VOLTS meter needle is not in the blue area proceed with steps in 3.03.3. If it is in the blue area proceed with steps in 3.03.4

3.03.3 Recharging the Battery

CAUTION

When the battery needs recharging the instrument will not give reliable readings.

a. Plug the power cord into an ac power outlet (115/230-volts, +10%, 50 to 400 Hz).

b. Turn off the instrument by pushing in the AUDIO control (inner knob). For the battery to become fully charged from a discharged state it will require 10 hours of charging at 120 ma.

NOTE

If it is necessary to use the instrument when the battery is in a completely discharged state, disconnect the battery terminals and store them at the two isolated terminals near the battery.

3.03.4 Calibration

a. Set the BATT CHK/OPR/CAL switch to CAL.

b. Set the LEVEL switch to -40 dBm (CAL) range.

c. Set the IMPEDANCE Ω switch to 75 CAL.

d. Set the PHASE LOCK/CONT switch to PHASE LOCK.

e. Set the BANDWIDTH switch to 200 Hz.

f. Tune MHz control (C1001) until tape mechanism indicates CAL in the readout window and LOCK/UNLOCK meter is in the LOCK position.

g. Tune kHz control (C1002) until tape mechanism indicates CAL in the readout window. Fine tune kHz control and FINE TUNE (R1002) until dBm/VOLTS meter peaks.

h. Adjust CAL potentiometer (R1001) until dBm/VOLTS meter needle is exactly on 0 (CAL).

j. The instrument is now ready for use.

NOTE

Calibration of the CE-24 can be performed regardless of any signal input.

3.03.5 Power or Voltage Measurements

NOTE

Voltage meter scales apply only to 600-ohm input impedance.

a. Set the INPUT switch to the UNBAL position. (For a balanced system, set to BAL).

b. Select the desired impedance with the IMPEDANCE Ω switch (outer knob).

c. Set the IMPEDANCE Ω switch (inner knob) to TERM position. (For an external termination set to BRDG).

NOTE

For high impedance (10kΩ) measurements set the IMPEDANCE Ω switch to BRDG.

d. Tune both the MHz and kHz controls (C1001 and C1002) to the desired frequency by phase-locking the MHz oscillator, and fine tuning kHz.

e. Adjust the LEVEL switch until the dBm/VOLTS meter needle reaches near the middle of the scale.

f. Peak the dBm/VOLTS meter with the kHz control and adjust the LEVEL switch as required.

g. Power and levels are read off the dBm/VOLTS meter scale as an algebraic sum of meter and level to the corresponding range of the LEVEL switch.

h. To search for signals, set the PHASE LOCK/CONT switch to CONT position, the BANDWIDTH switch to 2.3 kHz, and tune the MHz control until dBm/VOLTS meter scale peaks.

NOTE

To make any single frequency measurement, set the BANDWIDTH switch to the 200 Hz position and repeat steps a through g.

3.03.6 Bridging measurements

a. To bridge across a system, set the IMPEDANCE Ω switch (inner knob) to the BRDG position.

3.03.7 Noise Measurements

a. Set the BANDWIDTH switch to the 2.3 kHz (1.74 kHz Equivalent Noise) position.

b. Tune both the MHz and kHz controls (C1001 and C1002) to the desired frequency.

c. Adjust the LEVEL switch.

NOTE

dBrn direct readout with equivalent C-message weighting.

3.03.8 Signal Detection

a. Set the AUDIO control (outer knob) to the desired position (AM, LSB, or USB).

b. The audio output is available at the PHONES jack or speaker.

SECTION 4
THEORY OF OPERATION

4.01 INTRODUCTION

This section of the manual contains information necessary for an understanding of the operation of the Model CE-24 Frequency Selective Levelmeter. The functional block diagram of the Model CE-24 is discussed first to provide an understanding of the instrument as a whole. The circuits of the Model CE-24 are on six printed circuit boards: the First RF board, the Second LO board, the Audio and Meter Amplifier board, the Second IF board, the 100 kHz Phase-Lock board, and the VCO and Power Supply board. These boards, together with their applicable schematic diagrams, are discussed in detail later in this section.

4.02 FUNCTIONAL DESCRIPTION

The Model CE-24 Frequency Selective Levelmeter is a portable instrument which measures power levels and voltages in the frequency range from 1 kHz to 3.2 MHz. The CE-24 utilizes the double heterodyned method to obtain greater selectivity. The signal to be measured is applied to the INPUT connectors (J1001 and J1002) and is attenuated or fed directly to the balanced or unbalanced RF amplifier. (See drawing 3524000). The desired input impedance may be selected by the IMPEDANCE switch (S2001). High level signals are attenuated before being fed to the RF amplifier. The signal being amplified by the RF amplifier is summed and then fed to a lowpass filter which filters out undesired signals above 3.2 MHz. This signal is next heterodyned in the 1st mixer with a phase-locked Local Oscillator (1st LO) of 5.6 MHz to 8.7 MHz which produces a difference frequency of 5.55 MHz (1st IF). The 1st IF signal is amplified in the 1st IF Amplifier 1 and then applied to a bandpass filter which passes the 5.55 MHz at a bandwidth of 110 kHz. The output is then fed to a 1st IF Amplifier 2 providing isolation, before being passed to the 2nd IF board.

In the 2nd IF board the 1st IF is heterodyned in a second mixer with a second Local Oscillator (2nd LO) (tunable over the range of 5.045 MHz to 5.155 MHz) which produces a difference frequency of 455 kHz. This signal is then fed to a 2.3 kHz wideband crystal bandpass filter with a center frequency of 455 kHz. The output from the filter is fed to either a bandwidth matching network when the BANDWIDTH switch (S2004) is in the 2.3 kHz position; or a 200 Hz narrowband crystal filter with a center frequency of 455 kHz when the switch is in the 200 Hz position. The output is then amplified by 2nd IF Amplifier 1 and fed to an impedance loss pad. The amount of loss is determined by the position of the input IMPEDANCE selector switch.

The 455 kHz signal is amplifed by 2nd IF Amplifier 2 which drives the meter amplifier through the meter bridge, whose output drives the dBm/VOLTS meter. The 455 kHz signal is also amplified by a 2nd IF Amplifier 3 and fed to a product detector and an AM detector. When the front panel switch AUDIO (S2005) is in the USB or LSB position, a reinsertion carrier oscillator is turned on. The output of the product detector and AM detector is fed to an audio amplifier and is accessible at the PHONES jacks or speaker.

The 100 kHz reference signal is amplified by a calibration amplifier and is fed to the RF amplifiers (2100) through the BATT CHK/OPR/CAL switch (S1001) and LEVEL switch (S2003). When S1001 is in the CAL position the instrument can be calibrated. See 3.03.4 for procedures.

The 100 kHz signal is also fed to a harmonic generator for phase-locking the 5.6 MHz to 8.7 MHz Step-Locked Voltage Control Oscillator (VCO) in the 100 kHz steps. A dc output is derived from the phase-lock board when the meter is unlocked.

The 2nd LO is generated by mixing a 5.7 MHz voltage control crystal oscillator with a variable oscillator in the range from 545 kHz to 655 kHz. The resultant difference frequency is filtered by a bandpass filter and buffered before being fed into the 2nd mixer.

4.03 CIRCUIT DESCRIPTION

4.03.1 First RF Board 2100

The incoming signal is applied to pins 2100-15 and 2100-18. (See drawing 3524171). When a signal is present at 2100-18, it is amplified by Q2101 and Q2102 (RF amplifier 1). The output of Q2102 is fed to the base of Q2103 for summing with signals present at the base of Q2107. In the unbalanced mode, 2100-15 is grounded. During balance operation, the signal present at 2100-15 is amplified by Q2105 and Q2106 (RF amplifier 2). The output of Q2106 goes to the base of Q2107. Transistors Q2103 and Q2107 form a summing amplifier with a summated output for the signals present at their bases. This signal is developed across R2137 and fed to TP2101 through C2134.

The diodes at the inputs of Q2101 and Q2105 protect them from RF overloads, switching transients, and surge voltage.

The signal from Q2107 is ac coupled through C2134 and is fed to a 3.5 MHz lowpass filter. This output signal is then fed to a balanced mixer consisting of CR2103 through CR2106, T2101, T2102, R2115 through R2117, C2113 and C2114. The first LO of 5.6 MHz to 8.7 MHz originating from a VCO (2400-11) is applied to the mixer through 2100-11. Here the first LO and output signal are heterodyned to produce a resultant difference frequency.

This signal is buffered and impedance transformed by Q2104, with an output impedance of 3.3k ohms. The output impedance is matched with a bandpass filter tuned to a center

frequency of 5.55 MHz with a 0.1 dB ripple bandwidth of 110 kHz.

After the signal is passed through amplifier Q2108 and buffer amplifier Q2109, the output frequency of 5.50 MHz to 5.61 MHz is fed to the second mixer in the Second IF board (2500).

4.03.2 Second LO Board **2600**

By adjusting front panel control kHz (C1002) a frequency range of 545 kHz to 655 kHz is obtained from a Clapp oscillator consisting of Q2601, Q2602, and associated components. (See Drawing 3524172). This signal is fed to a lowpass filter consisting of C2621, C2622, C2623, R2614, L2604, and L2605. The signal is then mixed in a mixer consisting of CR2602, CR2603, and T2601 with a stable 5.7 MHz voltage control crystal oscillator consisting of Y2601, Q2603, and associated components. The resultant difference frequency is passed through a bandpass filter to wideband amplifier Q2604 and tuned second LO amplifier IC2601. The output frequency of 5.045 MHz to 5.155 MHz is fed to the second mixer in the Second IF board.

The 5.7 MHz crystal oscillator is controlled by varicap CR2601 which enables fine tuning of the tank capacitance. As a result the frequency of the second LO can be varied ±125 Hz by FINE TUNE control R1002.

4.03.3 Second IF Board **2500**

The first IF signal in the range of 5.50 MHz to 5.61 MHz from the First RF board (2100) is heterodyned with a second LO signal of 5.045 MHz to 5.155 MHz from the Second LO board (2600) in a second mixer consisting of T2501, T2502, and CR2501 through CR2504, which produces a difference frequency of 455 kHz. (See drawing 3524174). A swamped tank circuit consisting of C2501, C2502, L2501, and R2501 provides impedance matching between the 2nd mixer output and crystal filter input.

This signal is filtered by FL2501 which is a 2.3 kHz wideband crystal bandpass filter. If a 200 Hz bandwidth is required a 200 Hz narrowband crystal filter (FL2052) is switched in series with the 2.3 kHz filter resulting in a bandwidth of 200 Hz. Front panel control BANDWIDTH (S2004) enables selection of either bandwidth.

Potentiometer R2503 compensates for the insertion loss of the 200 Hz crystal bandpass filter in the 2.3 kHz mode of operation. The output from the crystal bandpass filters (whichever is selected) is fed to tuned Second IF Amplifier 1 consisting of Q2501 and associated components. This signal is then fed to a variable gain tuned amplifier consisting of Q2502, Q2503, and associated components. The gain of the amplifier is controlled by front panel control CAL (R1001). Potentiometer R2516 is used to control

the range of R1001.

The 455 kHz output from Q2502 is fed into a selectable loss pad (controlled by IMPEDANCE switch S2001), which provides different input impedances.

4.03.4 Audio and Meter Amplifier Board **2200**

The 455 kHz signal from the impedance loss pad is fed into the Audio and Meter Amplifier board (2200) via pin 2200-13 to a 600 ohm termination, R2201, (See drawing 3524173). This signal is then fed to second IF Amplifier 2 (Q2201) and is passed to meter amplifier Q2202, Q2203, and associated components. The output of the meter amplifier drives front panel meter M1001 through a meter bridge consisting of CR2201, CR2202, C2211, and C2212.

The 455 kHz from Q2201 is also amplified by Second IF Amplifier 3, which consists of one-half of integrated circuit IC2201. The other one-half of IC2201 is a product detector. The output of IC2201-5 is detected by IC2201-1.

A carrier reinsertion oscillator consisting of Q2205, Q2206, Q2207, Y2201, Y2202, and associated components, provide two modes of signal detection. These two modes of signal detection are lower sideband (LSB) and upper sideband (USB). When front panel control AUDIO (S2005) is set in the USB position a 457.0 kHz crystal frequency (Y2201) is injected into the product detector (IC2201-10). When the AUDIO switch is set in the LSB position a 453.0 kHz crystal frequency (Y2202) is injected in the same manner.

The audio output of the product detector (USB or LSB) is fed to an AM detector consisting of CR2203 and associated components. From here it is fed to a buffer amplifier (Q2204), a lowpass filter (C2223 and R2001), and subsequently to an audio amplifier consisting of Q2208 through Q2212. The output is then available at the front panel PHONES jack (J1004) or speaker.

When AM mode of operation is desired (S2005 in AM position), the -10 volts to the reinsertion carrier oscillator (USB or LSB) is removed from the product detector. Amplitude modulation is detected by CR2203 and associated components, and is buffered and amplified in the same manner as was previously discussed for USB and LSB detection.

4.03.5 100 kHz Phase-Lock Board **2300**

The reference 100 kHz signal is generated by a crystal oscillator consisting of Y2301, Q2304, Q2305, and associated components. (See drawing 3524176). This signal is fed to a calibration level amplifier consisting of Q2306 through Q2309, and associated components. The output is used as a source for calibrating the instrument. (Power is applied to the calibration amplifier only when S1001 is in the CAL position).

The 100 kHz signal is differentiated by C2310 and R2313 and amplified by Q2303 which clips the negative-going spikes. It is also differentiated again by C2309 and R2311, and amplified by Q2302 which clips the positive-going spikes. The positive-going spikes are then applied to the base of Q2301 via C2304 resulting in forward bias on the base-emitter junction and causing Q2301 to turn-on allowing a sharp pulse to be felt on both T2301 and T2302. The pulse developed across T2301 causes CR2301 through CR2306 to be turned on allowing a charge current to flow into C2329 which is a sample of the phase of the first LO signal. Any change in the charge of C2329 is fed through source follower Q2311 to the input of IC2301-1, and Q2310 which are connected as a differential amplifier. The output is an amplified replica of the phase error of the first LO. This error signal is then applied to the first LO (via PHASE LOCK/CONT switch) resulting in a slight frequency change, and the system is phase-locked. A portion of the error signal is also ac coupled to the input of IC2301-7 which is connected as a Schmitt Trigger. The output of IC2301-5 is applied through a voltage divider formed by R2341 and R2342 (via PHASE LOCK/CONT switch) to the LOCK/UNLOCK meter M1002 resulting in a lock indication.

4.03.6 VCO and Power Supply Board **2400**

The function of this board will be discussed in two parts, namely the VCO, and the power supply. (See Drawing 3524177). The CE-24 is wired to operate on either a 115- or 230-volt ac source and is fused by a 1/4 amp slo-blo fuse (F3001). Alternating current is rectified by a bridge consisting of CR2405 through CR2408. The dc output is fed to a 12.5-volt battery (BT2001) through a 180-ohm (R2002) and 470-ohm (R2003) parallel resistor which determines the charge current. When AUDIO switch (S2006) is in the OFF position the battery will be in a full charge condition providing the power cord is plugged into an appropriate ac source. If S2006 is in the ON position the CE-24 is energized and the battery is trickle-charged. When switch S1001 is set in the BATT CHK position a current which is a function of the battery voltage is fed to meter M1001 through R2424, indicating the charge condition of the battery.

The rectified voltage is then fed into a -10-volt regulator consisting of Q2407 through Q2410, and associated components. The -10 volts is then fed to all circuits.

The Voltage Control Oscillator (VCO) is a Clapp oscillator (Q2301 and Q2302) which generates a frequency in the range of from 5.6 MHz to 8.7 MHz. This VCO can operate in a continuous or phase-lock mode. In a continuous mode (S1002 in CONT) a fixed dc is applied to varicaps CR2401 and CR2402 holding its capacitance constant, and the VCO will generate at any frequency within its range (selected by front panel tuning).

In the phase-lock mode (S1002 in PHASE LOCK), a correction dc voltage is fed to the varicaps (CR2401 and CR2402) and the VCO will generate frequencies at 100 kHz increments.

The output level (1st LO) of the VCO is amplified by Q2304 through Q2306 and fed to the first mixer (2100). An output is also obtained from the collector of Q2304 and is fed to the sampling bridge to enable phase-locking at 100 kHz increments.

SECTION 5
MAINTENANCE

This section will be included in the final manual.

SECTION 6
SCHEMATICS AND PARTS LISTS

6.01 INTRODUCTION

This section of the manual contains all the necessary schematic diagrams for servicing and troubleshooting the Model CE-24 Frequency Selective Levelmeter. Also included are wiring diagrams which should provide additional assistance in troubleshooting.

6.02 SCHEMATICS AND PARTS LISTS

The parts lists and schematic diagrams on the following pages are assigned a Circuit Reference Series number shown in the upper right-hand corner of each page (parts lists) or in the lower right-hand corner of the page (schematics). These circuit reference series numbers correspond to the circuits discussed in Section 4. Exceptions to this are the wiring diagrams, which do not apply.

6.02.1 FIRST RF BOARD

CKT REF	DESCRIPTION	CE STOCK NO	MFR
2100	Board Assembly, First RF	7001-0073	Cushman
	Board, Printed Circuit	1780-0171	Cushman
	CAPACITORS		
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C2	Elect., 100 μF ±10%, 12V	1013-0011	Sprague
C3	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C5	Elect., 100 μF ±10%, 12V	1013-0011	Sprague
C6	Mica, 180 pF ±5%, 500V	1002-0005	Elmenco
C7	Mica, 33 pF ±5%, 500V	1002-0024	Elmenco
C8	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C9	Cer, Trimmer, 9 - 35 pF, N650, 350V	1001-0006	Erie
C10	Elect., 100 μF ±10%, 12V	1013-0011	Sprague
C11	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C12	Elect., 15 μF ±10%, 12V	1013-0015	Sprague
C13	Mica, 5 pF ±5%, 500V	1002-0028	Elmenco
C14	Var, Glass, 0.8 - 12 pF, 750V	1001-0007	Johnson
C15	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C16	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C17	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C18	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C19	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C20	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C21	Elect., 100 μF ±10%, 12V	1013-0011	Sprague
C22	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C23	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C24	Elect., 100 μF ±10%, 12V	1013-0011	Sprague
C25	Mica, 180 pF ±5%, 500V	1002-0005	Elmenco
C26	Mica, 33 pF ±5%, 500V	1002-0024	Elmenco
C27	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C28	Cer, Trimmer, 9 - 35 pF, N650, 350V	1001-0006	Erie
C29	Elect., 100 μF ±10%, 12V	1013-0011	Sprague
C30	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C31	Elect., 15 μF ±10%, 12V	1013-0015	Sprague
C32	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C33	Cer, Trimmer, 9 - 35 pF, N650, 350V	1001-0006	Erie
C34	Elect., 100 μF ±10%, 12V	1013-0011	Sprague
C35	Mica, 18 pF ±5%, 500V	1002-0014	Elmenco
C36	Mica, 560 pF ±5%, 300V	1002-0037	Elmenco
C37	Cer, Tubular, 36 pF ±0.25 pF, 500V	1005-0054	Erie
C38	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco

6.02.1 FIRST RF BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
C39	Cer, Trimmer, 9 - 35 pF, N650, 350V	1001-0006	Erie
C40	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco
C41	Cer, Tubular, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C42	Mica, 200 pF ±5%, 500V	1002-0042	Elmenco
C43	Cer, Trimmer, 9-35 pF, N650, 350V	1001-0006	Erie
C44	Mica, 120 pF ±5%, 500V	1002-0010	Elmenco
C45	Cer, Tubular, 36pF ±0.25 pF, 500V	1005-0054	Erie
C46	Cer, Tubular, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C47	Mica, 120 pF ±5%, 500V	1002-0010	Elmenco
C48	Cer, Trimmer, 9 - 35 pF, N650, 350V	1001-0006	Erie
C49	Mica, 820 pF ±5%, 300V	1002-0039	Elmenco
C50	Mica, 12 pF ±5%, 500V	1002-0017	Elmenco
C51	Cer, Tubular, 36 pF ±0.25 pF, 500V	1005-0054	Erie
C52	Mica, 470 pF ±5%, 500V	1002-0035	Elmenco
C53	Cer, Tubular, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C54	Mica, 15 pF ±5%, 500V	1002-0001	Elmenco
C55	Cer, Tubular, 36 pF ±0.25 pF, 500V	1005-0054	Erie
C56	Cer, Tubular, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C57	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C58	Mica, 33 pF ±5%, 500V	1002-0024	Elmenco
C59	Mica, 12 pF ±5%, 500V	1002-0017	Elmenco
C60	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C61	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C62	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C63	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie
C64	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
	DIODES		
CR1	Si, 1N3064	1281-0013	Sylvania
CR2	Si, 1N3064	1281-0013	Sylvania
CR3	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR4	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR5	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR6	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR7	Si, 1N3064	1281-0013	Sylvania
CR8	Si, 1N3064	1281-0013	Sylvania
	INDUCTORS		
L1	Choke, RF, 330 μH ±5%	1585-0045	Delevan
L2	Choke, RF, 330 μH ±5%	1585-0045	Delevan
L3	Choke, RF, 330 μH ±5%	1585-0045	Delevan
L4	Choke, RF, 330 μH ±5%	1585-0045	Delevan
L5	Var, 16 - 17 μH	7090-0026	Cushman

6.02.1 FIRST RF BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
L6	Toroid, 4.6 μH ±5%	1579-0024-03	Cushman
L7	Var, 16 - 17 μH	7090-0026	Cushman
L8	Toroid, 4.1 μH ±5%	1579-0024-02	Cushman
L9	Var, 16 - 17 μH	7090-0026	Cushman
L10	Toroid, 3.9 μH ±5%	1579-0024-01	Cushman
L11	Var, 16 - 17 μH	7090-0026	Cushman
L12	Var, 16 - 17 μH	7090-0026	Cushman
	RESISTORS		
R1	Met Film, 11.54kΩ ±0.25%, 0.15W	1074-0051	Dale
R2	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R3	Comp, 150kΩ ±5%, 1/4W	1066-1545	Allen-Bradley
R4	Comp, 150kΩ ±5%, 1/4W	1066-1545	Allen-Bradley
R5	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R6	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R7	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R8	Comp, 680Ω ±5%, 1/4W	1066-6815	Allen-Bradley
R9	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R10	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R11	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley
R12	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R13	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R14	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R15	Met Film, 51.1Ω ±1%, 1/8W	1075-0077	Dale
R16	Met Film, 51.1Ω ±1%, 1/8W	1075-0077	Dale
R17	Trimmer,Cer,Met,100Ω ±10%,3/4W	1215-0009	Helitrim
R18	Met Film, 301Ω ±1%, 1/8W	1075-0048	Dale
R19	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley
R20	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R21	Met Film, 11.54kΩ ±0.25%, 0.15W	1074-0051	Dale
R22	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R23	Comp, 150kΩ ±5%, 1/4W	1066-1545	Allen-Bradley
R24	Comp, 150kΩ ±5%, 1/4W	1066-1545	Allen-Bradley
R25	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R26	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R27	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R28	Comp, 680Ω ±5%, 1/4W	1066-6815	Allen-Bradley
R29	Trimmer,Cer,Met,500Ω ±10%,3/4W	1215-0011	Helitrim
R30	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R31	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley
R32	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R33	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley

6.02.1 FIRST RF BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
R34	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R35	Trimmer,Cer,Met,5kΩ ±10%, 3/4W	1215-0012	Helitrim
R36	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R37	Met Film, 75Ω ±1%, 1/8W	1075-0035	Dale
R38	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R39	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R40	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R41	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R42	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
R43	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R44	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley
R45	Comp, 75Ω ±5%, 1/4W	1066-7505	Allen-Bradley
	TRANSFORMERS		
T1	Toroid, Trifilar (8 turns)	1579-0017	Cushman
T2	Toroid, Trifilar (8 turns)	1579-0017	Cushman
T3	Toroid, Trifilar (8 turns)	1579-0017	Cushman
	TRANSISTORS		
Q1	Si, MOS FET, N-Channel, 3N140	1272-0028	RCA
Q2	Si, PNP, 2N4121	1272-0023	Fairchild
Q3	Si, PNP, 2N3906	1272-0037	Motorola
Q4	Si, FET, N-Channel, LS4416	1272-0048	Ledel
Q5	Si, MOS FET, N-Channel, 3N140	1272-0028	RCA
Q6	Si, PNP, 2N4121	1272-0023	Fairchild
Q7	Si, NPN, 2N3904	1272-0032	Motorola
Q8	Si, MOS FET, N-Channel, 3N140	1272-0028	RCA
Q9	Si, NPN, 2N4275	1272-0016	Fairchild

6.02.2 SECOND LO BOARD

CKT REF	DESCRIPTION	CE STOCK NO	MFR
2600	Board Assembly, Second LO	7001-0074	Cushman
	Board, Printed Circuit	1780-0172	Cushman
	CAPACITORS		
C1	Cer, 36 pf ±0.25pF, NPO, 500V	1005-0054	Erie
C2	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C4	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C5	Var, Air, 0.8-12.0 pF, 250V	1000-0010	Johnson
C6	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C7	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C8	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C9	Cer, 47 pF ±5%, NPO, 1000V	1005-0053	Sprague
C10	Mica, 360 pF ±5%, 500V	1002-0040	Sprague
C11	Mica, 620 pF ±5%, 300V	1002-0038	Sprague
C12	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco
C13	Mica, 5 pF ±0.5 pF, 500V	1002-0028	Elmenco
C14	Var, Air, 0.8-12.0 pF, 250V	1000-0010	Johnson
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C16	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C17	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C18	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C19	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C20	Mica, 68 pF ±5%, 500V	1002-0013	Sprague
C21	Mica, 680 pF ±5%, 500V	1002-0022	Elmenco
C22	Mica, 1500 pF ±5%, 500V	1002-0083	Elmenco
C23	Mica, 680 pF ±5%, 500V	1002-0022	Elmenco
C24	Mica, 150 pF ±5%, 500V	1002-0021	Elmenco
C25	Mica, 620 pF ±5%, 300V	1002-0038	Elmenco
C26	Mica, 150 pF ±5%, 500V	1002-0021	Elmenco
C27	Mica, 27 pF ±5%, 500V	1002-0008	Elmenco
C28	Mica, 470 pF ±5%, 500V	1002-0035	Elmenco
C29	Mica, 18 pF ±5%, 500V	1002-0014	Elmenco
C30	Mica, 470 pF ±5%, 500V	1002-0035	Elmenco
C31	Mica, 18 pF ±5%, 500V	1002-0014	Elmenco
C32	Mica, 470 pF ±5%, 500V	1002-0035	Elmenco
C33	Mica, 18 pF ±5%, 500V	1002-0014	Elmenco
C34	Mica, 470 pF ±5%, 500V	1002-0035	Elmenco
C35	Cer, 0.1 μF ±10%, 100V	1005-0064	Aerovox
C36	Cer, 0.1 μF ±10%, 100V	1005-0064	Aerovox
C37	Cer, 0.1 μF ±10%, 100V	1005-0064	Aerovox
C38	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie

6.02.2 SECOND LO BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
C39	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C40	Mica, 33 pF ±5%, 500V	1002-0024	Elmenco
*C41			
	CRYSTAL		
Y1	5.7 MHz	2035-0012	Cushman
	DIODES		
CR1	Varicap, V33, 33 pF ±20%	1281-0010	TRW
CR2	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR3	Si, Hot Carrier, HPA2800	1283-0001	HPA
	INDUCTORS		
L1	Var, 360 - 600 μH	1596-0031	Delevan
L2	Choke, RF, 100 μH ±5%	1585-0017	Delevan
L3	Choke, RF, 100 μH ±5%	1585-0017	Delevan
L4	Choke, RF, 82 μH ±5%	1596-0032	Delevan
L5	Choke, RF, 82 μH ±5%	1596-0032	Delevan
L6	Var, 4.1 μH	1596-0004	Cushman
L7	Var, 2.55 μH	7050-0028	Cushman
L8	Var, 2.55 μH	7050-0028	Cushman
L9	Var, 2.55 μH	7050-0028	Cushman
L10	Var, 2.55 μH	7050-0028	Cushman
L11	Var, 20μH	1596-0005	Cushman
	INTEGRATED CIRCUIT		
IC1	Ampl, RF, CA3028A	2025-0012	RCA
	RESISTORS		
R1	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R2	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R3	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R4	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R5	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R6	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R7	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R8	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R9	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R10	Comp, 82kΩ ±5%, 1/4W	1066-8235	Allen-Bradley
R11	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R12	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R13	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley

* Factory Select.

6.02.2 SECOND LO BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
R14	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R15	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R16	Comp, 68kΩ ±5%, 1/4W	1066-6835	Allen-Bradley
R17	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R18	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R19	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R20	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R21	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
	TRANSFORMER		
T1	Toroid, Trifilar (8 turns)	1579-0017	Cushman
	TRANSISTORS		
Q1	Si, NPN, 2N5089	1272-0031	Motorola
Q2	Si, NPN, 2N5089	1272-0031	Motorola
Q3	Si, NPN, 2N4275	1272-0016	Fairchild
Q4	Si, NPN, 2N4275	1272-0016	Fairchild

6.02.3 SECOND IF BOARD

CKT REF	DESCRIPTION	CE STOCK NO	MFR
2500	Board Assembly, Second IF	7001-0076	Cushman
	Board, Printed Circuit	1780-0174	Cushman
	CAPACITORS		
C1	Mica, 3900 pF ±5%, 500V	1002-0079	Elmenco
C2	Mica, 8200 pF ±5%, 100V	1002-0076	Elmenco
C3	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C4	Poly., 0.01 μF ±10%, 200V	1008-0043	Sprague
C5	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie
C6	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C7	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C8	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C9	Mica, 2700 pF ±5%, 500V	1002-0081	Elmenco
C10	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C11	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C12	Poly., 0.0039 μF ±10%, 100V	1008-0052	Sprague
C13	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C14	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C16	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C17	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
	DIODES		
CR1	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR2	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR3	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR4	Si, Hot Carrier, HPA2800	1283-0001	HPA
	FILTERS		
FL1	Bandpass, Crystal, 2.3 kHz	1040-0018	Cushman
FL2	Bandpass, Crystal, 200 Hz	1040-0019	Cushman
	INDUCTORS		
L1	Var, 50 μH	1596-0006	Cushman
L2	Var, 50 μH	1596-0006	Cushman
L3	Var, 50 μH	1596-0006	Cushman
	RESISTORS		
R1	Met Film, 5.62kΩ ±1%, 1/8W	1075-0013	Dale
R2	Met Film, 600Ω ±0.5%, 0.15W	1074-0023	Dale
R3	Trimmer, Cer, 100kΩ ±10%, 1/2W	1215-0006	Helitrim
R4	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R5	Met Film, 600Ω ±0.5%, 0.15W	1074-0023	Dale

6.02.3 SECOND IF BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
R6	Comp, 180kΩ ±5%, 1/4W	1066-1845	Allen-Bradley
R7	Comp, 820kΩ ±5%, 1/4W	1066-8245	Allen-Bradley
R8	Comp 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R9	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R10	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
R11	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R12	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R13	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R14	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R15	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R16	Trimmer, Cer, 100kΩ ±10%, 1/2W	1215-0006	Helitrim
	TRANSFORMERS		
T1	Toroid, Trifilar (8 turns)	1569-0017	Cushman
T2	Toroid, Trifilar (8 turns)	1479-0017	Cushman
	TRANSISTORS		
Q1	Si, MOS FET, N-Channel, 3N140	1272-0028	RCA
Q2	Si, NPN, 2N4275	1272-0016	Fairchild
Q3	Si, FET, N-Channel, Planar, 2N3819	1272-0039	TI

6.02.4 AUDIO/METER AMPLIFIER BOARD

CKT REF	DESCRIPTION	CE STOCK NO	MFR
2200	Board Assy., Audio/Meter Amplifier	7001-0075	Cushman
	Board, Printed Circuit	1780-0173	Cushman
	CAPACITORS		
C1	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague
C2	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague
C3	Mica, 2700 pF ±5%, 500V	1002-0081	Elmenco
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C5	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague
C6	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague
C7	Poly, 0.1 μF ±10±, 100V	1008-0031	Sprague
C8	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C9	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague
C10	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague
C11	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague
C12	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague
C13	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C14	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C16	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C17	Elect., 100 μF ±10%, 25V	1013-0003	Sprague
C18	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C19	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C20	Mica, 2700 pF ±5%, 500V	1002-0081	Elmenco
C21	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C22	Mica, 2700 pF ±5%, 500V	1002-0081	Elmenco
C23	Mica, 2700 pF ±5%, 500V	1002-0081	Elmenco
C24	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C25	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C26	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C27	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C28	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C29	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C30	Elect., 15 μF ±10%, 25V	1013-0005	Sprague
C31	Elect., 25 μF ±10%, 25V	1013-0010	Sprague
C32	Elect., 15 μF ±10%, 25V	1013-0005	Sprague
C33	Mica, 2700 pF ±5%, 500V	1002-0081	Elmenco
C34	Elect., 50 μF ±10%, 50V	1013-0007	Sprague
C35	Elect., 100 μF ±10%, 25V	1013-0003	Sprague
	CRYSTALS		
Y1	457 kHz	2035-0014	Cushman
Y2	453 kHz	2035-0011	Cushman

6.02.4 AUDIO/METER AMPLIFIER BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
	DIODES		
CR1	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR2	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR3	Si, 1N3064	1281-0013	Sylvania
CR4	Si, 1N3064	1281-0013	Sylvania
CR5	Si, 1N3064	1281-0013	Sylvania
CR6	Si, 1N3064	1281-0013	Sylvania
	INDUCTORS		
L1	Var, 50 μH	1596-0006	Cushman
L2	Choke, RF, 1000 μH ±5%	1585-0020	Delevan
L3	Var, 50 μH	1596-0006	Cushman
	INTEGRATED CIRCUIT		
IC1	Ampl, Diff, CA3026	2025-0026	RCA
	RESISTORS		
R1	Met Film, 600Ω ±0.5%, 0.15W	1074-0023	Dale
R2	Comp, 68kΩ ±5%, 1/4W	1066-6835	Allen-Bradley
R3	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R4	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R5	Trimmer, Cer, Met, 1kΩ ±10%, 3/4W	1215-0013	Helitrim
R6	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R7	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R8	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R9	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R10	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R11	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R12	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley
R13	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R14	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R15	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
*R16	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R17	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R18	Comp, 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley
R19	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R20	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R21	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R22	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R23	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley
R24	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley
R25	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley

*Factory Select. Typical value shown.

6.02.4 AUDIO/METER AMPLIFIER BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
R26	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R27	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R28	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R29	Comp, 33kΩ ±5%, 1/4W	1066-3335	Allen-Bradley
R30	Comp, 33kΩ ±5%, 1/4W	1066-3335	Allen-Bradley
R31	Comp, 33kΩ ±5%, 1/4W	1066-3335	Allen-Bradley
R32	Comp, 33kΩ ±5%, 1/4W	1066-3335	Allen-Bradley
R33	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R34	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R35	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R36	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R37	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R38	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley
R39	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R40	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R41	Comp, 39Ω ±5%, 1/4W	1066-3905	Allen-Bradley
R42	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R43	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R44	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R45	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R46	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R47	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R48	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R49	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R50	Comp, 68kΩ ±5%, 1/4W	1066-6835	Allen-Bradley
R51	Comp, 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley
R52	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R53	Comp, 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley
R54	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
R55	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R56	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R57	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R58	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R59	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R60	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3565	1272-0017	Fairchild
Q2	Si, NPN, 2N3565	1272-0017	Fairchild
Q3	Si, PNP, 2N3639	1271-0009	Fairchild
Q4	Si, PNP, 2N4121	1272-0023	Fairchild
Q5	Si, NPN, 2N3565	1272-0017	Fairchild

6.02.4 AUDIO/METER AMPLIFIER BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
Q6	Si, NPN, 2N3565	1272-0017	Fairchild
Q7	Si, NPN, 2N3565	1272-0017	Fairchild
Q8	Si, NPN, 2N3565	1272-0017	Fairchild
Q9	Si, NPN, 2N3565	1272-0017	Fairchild
Q10	Si, PNP, 2N4121	1272-0023	Fairchild
Q11	Si, NPN, 2N3053	1272-0011	RCA
Q12	Si, NPN, 2N3053	1272-0011	RCA

6.02.5 100 kHz PHASE LOCK BOARD

CKT REF	DESCRIPTION	CE STOCK NO	MFR
2300	Board Assy., 100 kHz Phase Lock	7001-0077	Cushman
	Board, Printed Circuit	1780-0176	Cushman
	CAPACITORS		
C1	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco
C2	Mica, 68 pF ±5%, 500V	1002-0013	Elmenco
C3	Mica, 68 pF ±5%, 500V	1002-0013	Elmenco
C4	Mica, 75 pF ±5%, 500V	1002-0025	Elmenco
C5	Cer, Tubular, 2.2 pF ±0.25 pF, 500V	1005-0017	Erie
C6	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C7	Mica, 150 pF ±5%, 500V	1002-0021	Elmenco
C8	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C9	Mica, 27 pF ±5%, 500V	1002-0008	Elmenco
C10	Mica, 27 pF ±5%, 500V	1002-0008	Elmenco
C11	Cer, Trimmer, 9-35 pF, N650, 350V	1001-0005	Erie
C12	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C13	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C14	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C15	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C16	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C17	Elect., 15 μF ±10%, 12V	1013-0015	Sprague
C18	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C19	Elect., 3.3 μF ±10%, 15V	1011-0008	Kemet
C20	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C21	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C22	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C23	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C24	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C25	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C26	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C27	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C28	Mica, 47 pF ±5%, 500V	1002-0012	Elmenco
C29	Mica, 39 pF ±10%, 500V	1002-0018	Elmenco
C30	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
	CRYSTAL		
Y1	100 kHz	2035-0013	Cushman
	DIODES		
CR1	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR2	Si, 1N3064	1281-0013	Sylvania
CR3	Si, 1N3064	1281-0013	Sylvania

6.02.5 100 kHz PHASE LOCK BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
CR4	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR5	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR6	Si, Hot Carrier, HPA2800	1283-0001	HPA
CR7	Si, 1N3064	1281-0013	Sylvania
	INDUCTOR		
L1	Choke, RF, 1000 μH ±5%	1585-0020	Delevan
	INTEGRATED CIRCUIT		
IC1	Ampl, Diff, CA3026	2025-0026	RCA
	RESISTORS		
R1	Comp, 8.2kΩ ± 5%, 1/4W	1066-8225	Allen-Bradley
R2	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R3	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R4	Comp, 820kΩ ±5%, 1/4W	1066-8245	Allen-Bradley
R5	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R6	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
R7	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
R8	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R9	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R10	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R11	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R12	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R13	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R14	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley
R15	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R16	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R17	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R18	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R19	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R20	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R21	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R22	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R23	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R24	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R25	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R26	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R27	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R28	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R29	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R30	Comp, 39Ω ±5%, 1/4W	1066-3905	Allen-Bradley

6.02.5 100 kHz PHASE LOCK BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
R31	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley
R32	Trimmer, Cer, 100Ω, ±10%, 3/4W	1215-0010	Helitrim
R33	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R34	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R35	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley
R36	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R37	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R38	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R39	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R40	Trimmer, Cer, 100kΩ ±10%, 1/2W	1215-0006	Helitrim
R41	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley
R42	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R43	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R44	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley
R45	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R46	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R47	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R48	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R49	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R50	Trimmer, Cer, 10kΩ ±10%, 3/4W	1215-0014	Helitrim
R51	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R52	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley
R53	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R54	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R55	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R56	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
	TRANSFORMERS		
T1	Toroid, Trifilar (8 turns)	1579-0017	Cushman
T2	Toroid, Trifilar (8 turns)	1579-0017	Cushman
	TRANSISTORS		
Q1	Si, NPN, 2N4275	1272-0016	Fairchild
Q2	Si, PNP, 2N4121	1272-0023	Fairchild
Q3	Si, NPN, 2N4275	1272-0016	Fairchild
Q4	Si, NPN, 2N3565	1272-0017	Fairchild
Q5	Si, NPN, 2N3565	1272-0017	Fairchild
Q6	Si, NPN, 2N4275	1272-0016	Fairchild
Q7	Si, NPN, 2N4275	1272-0016	Fairchild
Q8	Si, NPN, 2N4275	1272-0016	Fairchild
Q9	Si, NPN, 2N4275	1272-0016	Fairchild
Q10	Si, PNP, 2N4121	1272-0023	Fairchild
Q11	Si, FET, N-Channel, Planar, 2N3819	1272-0039	TI

6.02.6 VCO and POWER SUPPLY BOARD

CKT REF	DESCRIPTION	CE STOCK NO	MFR
2400	Board Assembly, VCO and Power Supply	7001-0078	Cushman
	Board, Printed Circuit	1780-0177	Cushman
	CAPACITORS		
C1	Var, Glass, 0.8 - 12 pF, 750V	1001-0007	JFD
C2	Poly., 0.39 μF ±10%, 200V	1008-0037	Electrocube
C3	Mica, 27 pF ±5%, 500V	1002-0008	Elmenco
C4	Mica, 150 pF ±5%, 500V	1002-0021	Elmenco
C5	Mica, 150 pF ±5%, 500V	1002-0021	Elmenco
C6	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C7	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague
C8	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C9	Mica, 150 pF ±5%, 500V	1002-0021	Elmenco
C10	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C11	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C12	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C13	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie
C14	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie
C15	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C16	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C17	Mica, 200 pF ±5%, 500V	1002-0042	Elmenco
C18	Mica, 47 pF ±5%, 500V	1002-0012	Elmenco
C19	Mica, 330 pF ±5%, 500V	1002-0032	Elmenco
C20	Elect., 50 μF ±10%, 50V	1013-0007	Sprague
C21	Elect., 4000 μF ±10%, 25V	1014-0005	Sprague
C22	Elect., 3.3 μF ±10%, 15V	1011-0008	Kemet
C23	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie
C24	Elect., 25 μF ±10%, 25V	1013-0010	Sprague
	DIODES		
CR1	Varicap, V33, 33 pF 20%	1281-0010	TRW
CR2	Varicap, V33, 33 pF 20%	1281-0010	TRW
CR3	Si, 1N3064	1281-0013	ITT
CR4	Si, 1N3064	1281-0013	ITT
CR5	Si, 1N4002	1281-0023	ITT
CR6	Si, 1N4002	1281-0023	ITT
CR7	Si, 1N4002	1281-0023	ITT
CR8	Si, 1N4002	1281-0023	ITT
CR9	Si, 1N821A	1281-0035	Motorola
	INDUCTORS		
L1	Var, 2.0 - 6.0 μH	1596-0032	Delevan
L2	Choke, RF, 120 μH ±5%	1585-0033	Delevan

6.02.6 VCO and POWER SUPPLY BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
L3	Choke, RF, 1.5 μH ±10%	1585-0038	Delevan
L4	Choke, RF, 1.5 μH ±10%	1585-0038	Delevan
	RESISTORS		
R1	Comp, 150kΩ ±5%, 1/4W	1066-1545	Allen-Bradley
R2	Comp, 150kΩ ±5%, 1/4W	1066-1545	Allen-Bradley
R3	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R4	Comp, 39kΩ ±5%, 1/4W	1066-3935	Allen-Bradley
R5	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R6	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R7	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R8	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley
R9	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R10	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley
R11	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R12	Met Film, 47.5kΩ ±1%, 1/8W	1075-0076	Dale
R13	Met Film, 18.2kΩ ±1%, 1/8W	1075-0075	Dale
R14	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R15	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R16	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R17	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R18	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
R19	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R20	Met Film, 47.5kΩ ±1%, 1/8W	1075-0076	Dale
R21	Met Film, 18.2kΩ ±1%, 1/8W	1075-0075	Dale
R22	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R23	Comp, 75Ω ±5%, 1/4W	1066-7505	Allen-Bradley
R24	Met Film, 143kΩ ±1%, 1/8W	1075-0050	Dale
R25	Comp, 1Ω ±5%, 1/2W	1067-0001	Allen-Bradley
R26	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R27	Comp, 330Ω ±5%, 1/4W	1066-3315	Allen-Bradley
R28	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R29	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R30	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R31	Trimmer, Cer, 10kΩ, ±10%, 3/4W	1215-0014	Helitrim
R32	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3565	1272-0017	Fairchild
Q2	Si, NPN, 2N4275	1272-0016	Fairchild
Q3	Si, NPN, 2N4275	1272-0016	Fairchild
Q4	Si, NPN, 2N4275	1272-0016	Fairchild
Q5	Si, NPN, 2N4275	1272-0016	Fairchild

6.02.6 VCO and POWER SUPPLY BOARD (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
Q6	Si, PNP, 2N3639	1271-0009	Fairchild
Q7	Si, NPN, 2N3565	1272-0017	Fairchild
Q8	Si, PNP, 2N4121	1272-0023	Fairchild
Q9	Si, NPN, 2N3053	1272-0011	RCA
Q10	Si, PNP, 2N4121	1272-0023	Fairchild

6.02.7 FRONT PANEL ASSEMBLY

CKT REF	DESCRIPTION	CE STOCK NO	MFR
1000	Assembly, Front Panel	7003-0031	Cushman
	Panel, Front	2800-0042	Cushman
	Assembly, kHz Tape Drive	7040-0008-01	Cushman
	Assembly, MHz Tape Drive	7040-0008-02	Cushman
	CAPACITORS		
C1	Var, Air, 0.0 - 114 pF ±0.2%	p/o7040-0008-02	Cushman
C2	Var, Air, 0.0 - 57 pF ±0.2%	p/o7040-0008-01	Cushman
	JACKS		
J1	Twin Coaxial, Female, #J15DW (Mounted on left-side panel)	2586-0013	Trompeter
J2	Twin Coaxial, Female, #J15DW (Mounted on left-side panel)	p/o2586-0013	Trompeter
J3	Phone, 3-cond, S Closed Ckt.	2586-0011	Switchcraft
J4	Phone, 3-cond, S Closed Ckt.	2586-0011	Switchcraft
	KNOBS		
	Round, Black E/W IND line, 0.510 Dia., (CAL)	2780-0023	Rogan
	Round, Black E/W IND line, 0.510 Dia., (TERM/BRDG)	2780-0023	Rogan
	Round, Black E/W IND line, 0.510 Dia., (VOL/PULL ON)	2780-0023	Rogan
	Round, Black E/W IND line, 0.510 Dia., (FINE TUNE)	2780-0023	Rogan
	Round, Black E/W line & Thru-hole 0.713 Dia., (IMPEDANCE)	2780-0025	Rogan
	Round, Black E/W line & Thru-hole 0.713 Dia., (AUDIO)	2780-0025	Rogan
	Round, Black, 0.920 Dia., (MHz)	2780-0026	Rogan
	Round, Black, 0.920 Dia., (kHz)	2780-0026	Rogan
	Round, Black E/W IND line, 0.713 Dia., (BANDWIDTH)	2780-0027	Rogan
	Bar, Black E/W IND line, 1.150 Dia., (LEVEL)	2780-0028	Rogan
	METERS		
M1	Microammeter, DC, 0 - 100 μA	1402-0024	Cushman
M2	Panel, Miniature, 0 - 200 μA	1402-0026	Cyclotronics
	RESISTORS		
R1	Pot., Trimmer, 1kΩ ±10%, 1/2W	1203-0035	Allen-Bradley
R2	Pot., Trimmer, 100kΩ ±10%, 1/2W	1203-0036	Allen-Bradley

6.02.7 FRONT PANEL ASSEMBLY (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
R3	Comp, 75Ω ±5%, 1/4W	1066-7505	Allen-Bradley
R4	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley
R5	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
	SWITCHES		
S1	Lever, 3-Position	1851-0052	Cushman
S2	Lever, 2-Position	1851-0054	Cushman
S3	Lever, 2-Position	1851-0053	Cushman

6.02.8 MAIN CHASSIS ASSEMBLY

CKT REF	DESCRIPTION	CE STOCK NO	MFR
2000	Assembly, Main Chassis	7007-0005	Cushman
	Chassis, Main	2275-0008	Cushman
	Switch Assembly, Level	7011-0009	Cushman
	Switch Assembly, Impedance	7011-0010	Cushman
	BATTERY		
BT1	Cadmium, Nickel, 12.5V	1046-0001	Cushman
	CAPACITORS		
C1	Cer, Tubular, 0.68 pF ±0.25%, 500V	1005-0039	Erie
C2	Cer, Trimmer, Tubular, 1.2 - 10 pF, 250V	1001-0011	Stettner-Trush
C3	Mica, 27 pF ±5%, 500V	1004-0004	Cornell-Dubilier
C4	Cer, Trimmer, Tubular, 1.2 - 10 pF, 250V	1001-0011	Stettner-Trush
C5	Mica, 22 pF ±5%, 500V	1004-0003	Cornell-Dubilier
C6	Cer, Tubular, 8.2 pF ±0.25 pF, 500V	1005-0043	Erie
C7	Mica, 33 pF ±5%, 500V	1004-0006	Cornell-Dubilier
C8	Cer, Trimmer, Tubular, 1.2 - 10 pF, 250V	1001-0011	Stettner-Trush
C9	Cer, Tubular, 0.68 pF ±0.25%, 500V	1005-0039	Erie
C10	Mica, 36 pF ±5%, 500V	1004-0007	Cornell-Dubilier
C11	Cer, Trimmer, Tubular, 1.2 - 10 pF, 250V	1001-0011	Stettner-Trush
C12	Cer, Tubular, 0.68 pF ±0.25 pF, 500V	1005-0039	Erie
C13	Cer, Trimmer, Tubular, 1.2 - 10 pF, 250V	1001-0011	Stettner-Trush
C14	Mica, 36 pF ±5%, 500V	1004-0007	Cornell-Dubilier
C15	Cer, Tubular, 8.2 pF ±0.25 pF, 500V	1005-0043	Erie
C16	Cer, Trimmer, Tubular, 1.2 - 10 pF, 250V	1001-0011	Stettner-Trush
C17	Cer, Trimmer, Tubular, 1.2 - 10 pF, 250V	1001-0011	Stettner-Trush
C18	Mica, 33 pF ±5%, 500V	1004-0006	Cornell-Dubilier
C19	Mica, 22 pF ±5%, 500V	1004-0003	Cornell-Dubilier
C20	Mica, 27 pF ±5%, 500V	1004-0004	Cornell-Dubilier

6.02.8 MAIN CHASSIS ASSEMBLY (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
C21	Cer, Trimmer, Tubular, 1.2 - 10 pF, 250V	1001-0011	Stettner-Trush
C22	Cer, Tubular, 0.68 pF ±0.25pF, 500V	1005-0039	Erie
	CONNECTORS		
J1	PC, Single Row, 18-pin	2535-0028	Masterite
J2	PC, Single Row, 18-pin	2535-0028	Masterite
J3	PC, Single Row, 18-pin	2535-0028	Masterite
J4	PC, Single Row, 18-pin	2535-0028	Masterite
J5	PC, Single Row, 18-pin	2535-0028	Masterite
J6	PC, Single Row, 18-pin	2535-0028	Masterite
	FUSE		
F1	Slo-Blo, 3 AG, 1/4 Amp	1955-0013	Littlefuse
	FUSEHOLDER		
X1	Extractor Post, 3 AG Fuse	1965-0001	Littlefuse
	INDUCTORS		
L1	Choke, RF, 2.5 turns	1586-0001	Ferroxcube
L2	Choke, RF, 2.5 turns	1586-0001	Ferroxcube
L3	Choke, RF, 2.5 turns	1586-0001	Ferroxcube
L4	Choke, RF, 2.5 turns	1586-0001	Ferroxcube
	RESISTORS		
R1	Pot., Tapered, SPST, 5k	p/o1851-0056	Cushman
R2	WW, 180Ω ±1.0%, 5W	1160-0001	Dale
R3	Comp, 470Ω ±5%, 2W	1069-4715	Allen-Bradley
R4	Met Film, 4.799kΩ ±0.25%, 0.15W	1074-0032	Dale
R5	Met Film, 4.113kΩ ±0.25%, 0.15W	1074-0030	Dale
R6	Met Film, 3.497kΩ ±0.25%, 0.15W	1074-0029	Dale
R7	Met Film, 1.25kΩ ±0.25%, 0.15W	1074-0047	Dale
R8	Met Film, 742.5Ω ±0.25%, 0.15W	1074-0046	Dale
R9	Met Film, 212.1Ω ±0.25%, 0.15W	1074-0021	Dale
R10	Met Film, 152.4Ω ±0.25%, 0.15W	1074-0018	Dale
R11	Met Film, 178.9Ω ±0.25%, 0.15W	1074-0020	Dale
R12	Met Film, 1.256kΩ ±0.25%, 0.15W	1074-0047	Dale
R13	Met Film, 3.497kΩ ±0.25%, 0.15W	1074-0029	Dale
R14	Met Film, 4.113kΩ ±0.25%, 0.15W	1074-0030	Dale
R15	Met Film, 4.799kΩ ±0.25%, 0.15W	1074-0032	Dale
R16	Met Film, 75.42Ω ±0.5%, 0.15W	1074-0009	Dale
R17	Met Film, 125.1Ω ±0.5%, 0.15W	1074-0015	Dale
R18	Met Film, 136.3Ω ±0.5%, 0.15W	1074-0016	Dale

6.02.8 MAIN CHASSIS ASSEMBLY (Continued)

CKT REF	DESCRIPTION	CE STOCK NO	MFR
R19	Met Film, 151.6Ω ±0.5%, 0.15W	1074-0017	Dale
R20	Met Film, 628.4Ω ±0.25%, 0.15W	1074-0045	Dale
R21	Met Film, 101Ω ±0.25%, 0.15W	1074-0013	Dale
R22	Met Film, 9.9kΩ ±0.25%, 0.15W	1074-0035	Dale
R23	Met Film, 6.835kΩ ±0.25%, 0.15W	1074-0033	Dale
R24	Met Film, 4.625kΩ ±0.25%, 0.15W	1074-0031	Dale
R25	Met Film, 9kΩ ±0.25%, 0.15W	1074-0034	Dale
R26	Met Film, 1.111kΩ ±0.25%, 0.15W	1074-0026	Dale
R27	Met Film, 9.9kΩ ±0.25%, 0.15W	1074-0035	Dale
R28	Met Film, 101Ω ±0.25%, 0.15W	1074-0013	Dale
R29	Met Film, 9.9kΩ ±0.25%, 0.15W	1074-0035	Dale
R30	Met Film, 101Ω ±0.25%, 0.15W	1074-0013	Dale
R31	Met Film, 9kΩ ±0.25%, 0.15W	1074-0034	Dale
R32	Met Film, 1.111kΩ ±0.25%, 0.15W	1074-0026	Dale
R33	Met Film, 6.835kΩ ±0.25%, 0.15W	1074-0033	Dale
R34	Met Film, 4.625kΩ ±0.25%, 0.15W	1074-0031	Dale
R35	Met Film, 101Ω ±0.25%, 0.15W	1074-0013	Dale
R36	Met Film, 9.9kΩ ±0.25%, 0.15W	1074-0035	Dale
	SWITCHES		
S1	Rotary, Concentric	1851-0051	Cushman
S2	Rotary, Concentric	1851-0051	Cushman
S3	Rotary, 11-position	1851-0050	Cushman
S4	Rotary, Concentric	1851-0055	Cushman
S5	Rotary, Concentric, E/W Pot.	1851-0056	Cushman
S6	Rotary, Concentric, E/W Pot.	1851-0056	Cushman
	TERMINAL STRIP		
TB1	Lug Type, 3-terminal	1760-0016	Cinch-Jones

CKT REF	DESCRIPTION	CE STOCK NO	MFR
3000	Assembly, Rear Panel	7003-0032	Cushman
	Panel, Rear	2800-0043	Cushman
	CAPACITORS		
C1	Cer, 0.02 μH ±20%, 1000V	1005-0040	Erie
C2	Cer, 0.02 μH ±20%, 1000V	1005-0040	Erie
	CONNECTORS		
J1	Recp., BNC, UG-1094/U	2536-0010	Kings
J2	Recp., 3-pin AC, 7A, 115V	2535-0030	Switchcraft
	FUSE		
F1	Slo-Blo, 3 AG, 1/4 Amp	1955-0013	Littlefuse
	FUSEHOLDER		
X1	Extractor Post, 3 AG Fuse	1965-0001	Littlefuse
	SWITCH		
S1	Slide, 2-position locking	1850-0012	Switchcraft
	TRANSFORMER		
T1	Power, 115/230 vac ±10%	1575-0011	Cushman

6.02.10 MISCELLANEOUS ASSEMBLIES

CKT REF	DESCRIPTION	CE STOCK NO	MFR
	Assembly, Top Cover	7005-0010	Cushman
	Assembly, Bottom Cover	7005-0011	Cushman
	Assembly, Front Cover	7005-0013	Cushman
	Assembly, Left Side Panel	7004-0005	Cushman
	Assembly, Right Side Panel	7004-0006	Cushman
	Assembly, Level & Impedance Switch Housing	7046-0009	Cushman
	Assembly, Main Wiring Harness	7030-0060	Cushman

IMPEDANCE Ω

J1001

INPUT

TERM

BRDG

S2002

IMPEDANCE Ω
S2001

BAL

S1003

UNBAL

J1002

BATT CHK

OPR

CAL

S1001

ATTENUATOR

LEVEL CAL

S2003

BATT CHK

OPR

CAL

ATTENUATOR

BT2001

BATTERY
12.5V

FIRST RF BOARD
2100

18

RF AMPLIFIER #1

15

RF AMPLIFIER #2

SUMMING AMPLIFIER

LOWPASS FILTER

FIRST MIXER

11

FIRST IF AMPLIFIER #1

BANDPASS FILTER BW=110 kHz

FIRST IF AMPLIFIER #2

7

SECOND IF BOARD
2500

10

SECOND MIXER

12

WIDEBAND CRYSTAL BANDPASS FILTER BW=2.3 kHz

14

BANDWIDTH MATCHING NETWORK

7 8

NB CRYSTAL BANDPASS FILTER BW=200 Hz

15 17

SECOND IF AMPLIFIER #1

2

5

BANDWIDTH
NOISE

200 Hz

2.3 kHz

S2004

2.3 kHz

200 Hz

600 150 135 124 75

IMPEDANCE LOSS PADS
Part of S2001

600 150 135 124 75

-10V

TO BATT CHK / OPER / CAL

100 kHz PHASE LOCK BOARD
2300

5

CAL LEVEL AMPLIFIER

100 kHz CRYSTAL OSC

HARMONIC GENERATOR

SCHMITT TRIGGER

DC AMPLIFIER

PHASE DISCR

17

14

5.6-8.7 MHz STEP-LOCKED VCO

15

POWER SUPPLY

4 9 2

VCO AND POWER SUPPLY BOARD
2400

SECOND LO BOARD
2600

14

545-655 kHz OSC

BANDPASS FILTER BW=110 kHz

SECOND LO AMPLIFIER

3

LOWPASS FILTER

SECOND LO MIXER

5.7 MHz VCXO

17 16

15 14

R1005

-10V

PHASE LOCK

S1002

CONT

C1001

MHz

C1002

kHz

-10V

R1002

FINE TUNE

AUDIO AND METER AMPLIFIER BOARD
2200

13

SECOND IF AMPLIFIER #2

METER DETECTOR

M1001

dBm

FROM 2400-2

BATT CHK

OPR

CAL

11

9

J3001

RECORDER

METER AMPLIFIER

PRODUCT & AM DETECTOR

AUDIO AMPLIFIER

3

J1003

PHONES

R1004

J1004

6

VOL

17

R2001

AUDIO

SECOND IF AMPLIFIER #3

CARRIER REINSERTION OSCILLATORS

15

14

USB

LSB

AM

S2005

-10V

NOTES:

1. Voltage scale is true only when 600Ω input impedance is selected (S2001) or a 600Ω external termination is used with BRDG/TERM switch (S2002) in the BRDG position.
2. 100 kHz, calibration signal, to allow calibration of the CE-24 within ±0.1 db of absolute zero db level.
3. 1st LO is step-locked in 100 kHz increments or continuously tunable in the range of 5.6 to 8.7 MHz.
4. 5.045 - 5.155 MHz 2nd LO.
5. 453 kHz - Crystal generated reinsertion signal for LSB operation.
   457 kHz - Crystal generated reinsertion signal for USB operation.
   No signal generated for AM operation.

CUSHMAN ELECTRONICS INC

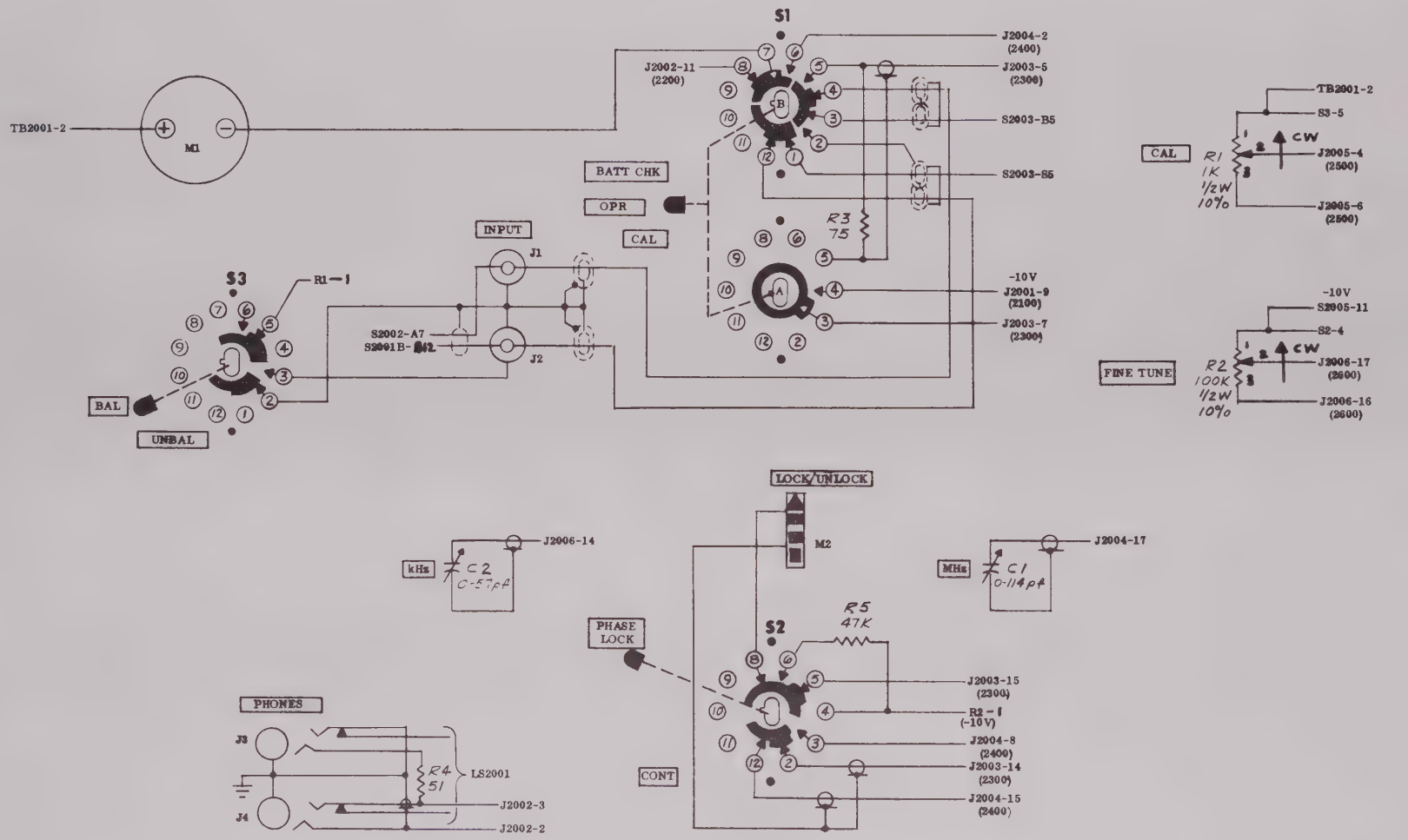
SCALE: —	APPROVED BY	DRAWN BY
DATE: 12-23-70	12-23-70	REVISED

CE-24 OVERALL BLOCK DIAGRAM

DRAWING NUMBER 3524000

25334 PRINTED ON NO. 1080M-10 CLEARPRINT

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



CIRCUIT REFERENCE SERIES: 1000

CIRCUIT REFERENCE USED:

C(100)1 - C(100)2	Q( ) - Q( )
CR( ) - CR( )	R(100)1 - R(100)5
DS( ) - DS( )	S( ) - S( )
F( ) - F( )	T( ) - T( )
IC( ) - IC( )	Y( ) - Y( )
L( ) - L( )	

CUSHMAN ELECTRONICS, INC

SCALE:

APPROVED BY:

DRAWN BY C.R

DATE: 12-16-70 12-29-70

REVISED

FRONT PANEL WIRING DIAGRAM

24-1000

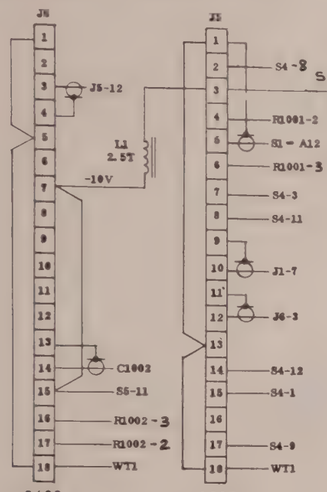
DRAWING NUMBER 3524001

1000

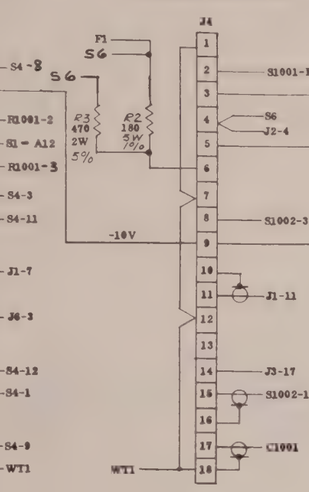
17233 PRINTED ON NO. 1000M-10 CLEARPRINT

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
1	EC-30	1-11-71	
2	EC-35	3-8-71	
3	EC-58	7-22-71	7-23-71

SECOND LO BOARD

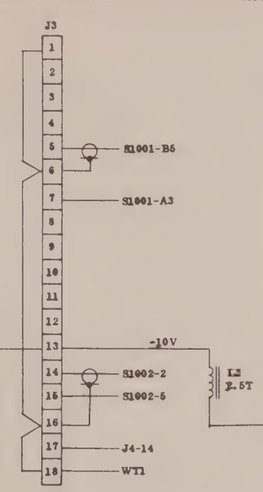


SECOND IF BOARD

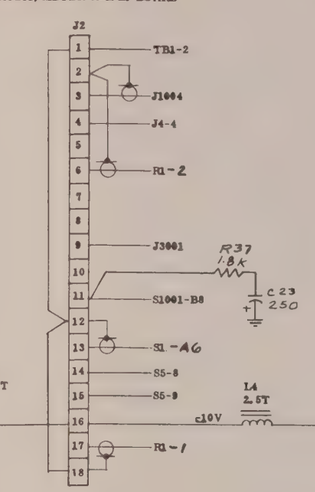


VCO & POWER SUPPLY BOARD

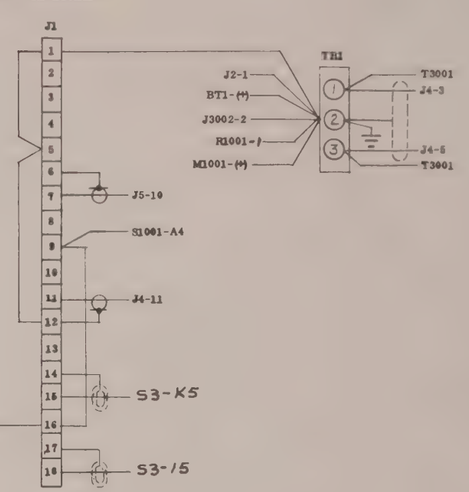
100 kHz PHASE LOCK BOARD

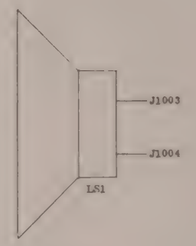


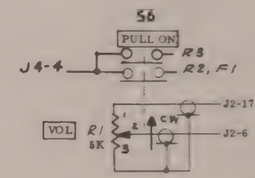
AUDIO/METER AMPL. BOARD

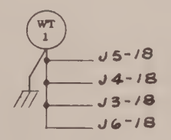


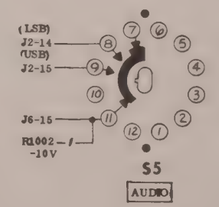
FIRST RF BOARD

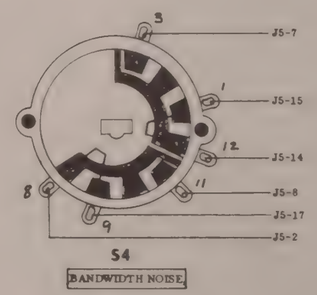


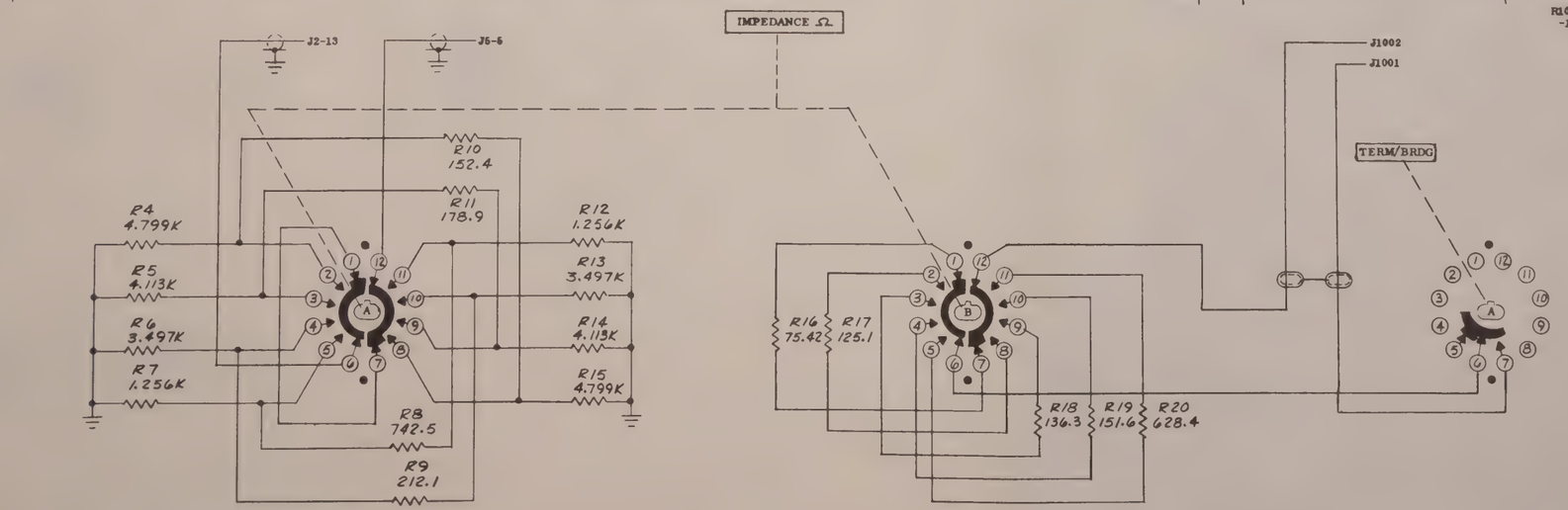


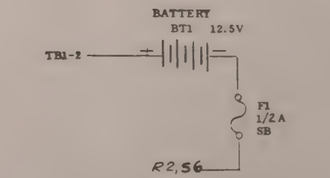












NOTE:
1. RESISTORS - 0.25W, 0.25% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

CIRCUIT REFERENCE SERIES: 2000

CIRCUIT REFERENCE USED:	
C( ) - C( )	Q( ) - Q( )
CR( ) - CR( )	R(2001) - R(2020)
DS( ) - DS( )	S( ) - S( )
F(2001) - F(2001)	T( ) - T( )
IC( ) - IC( )	Y( ) - Y( )
L(2001) - L(2004)	

CUSHMAN ELECTRONICS, INC.

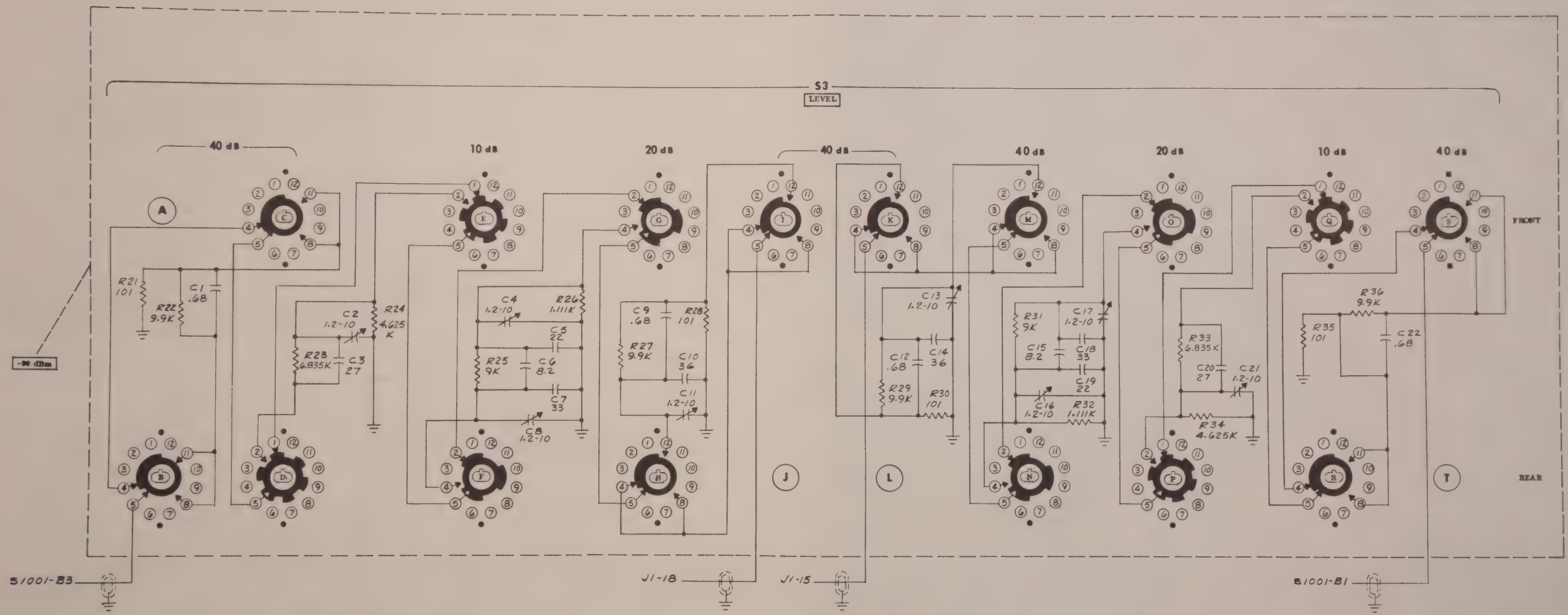
SCALE:	APPROVED BY:	DRAWN BY C.E
DATE: 12-16-70	12-29-70	REVISED

MAIN CHASSIS WIRING DIAGRAM

SHT 1 OF 2 | 24-2000 | DRAWING NUMBER 3524002

2000

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
1	EC-42	3-1-71	



NOTE:

1. RESISTORS - 0.15W, 0.25% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN pf UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

CIRCUIT REFERENCE SERIES: 2000

CIRCUIT REFERENCE USED:	
C(2001 - C(20)23	Q( ) - Q( )
CR( ) - CR( )	R(20)21 - R(20)37
DS( ) - DS( )	S( ) - S( )
F( ) - F( )	T( ) - T( )
IC( ) - IC( )	Y( ) - Y( )
L( ) - L( )	

CUSHMAN ELECTRONICS, INC.

SCALE:	APPROVED BY:	DRAWN BY C. R
DATE: 12-15-70	J. Smith 12-29-70	REVISED

MAIN CHASSIS WIRING DIAGRAM

SHT 2 of 2 | 24-2000 | DRAWING NUMBER 3524002

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

RF AMPLIFIER 1 — SUMMING AMPLIFIER — FIRST MIXER — FIRST IF AMPLIFIER 1

P1/J2001

S2003-I5 — 18

17

CR1 1N3064 — CR2 1N3064

R1 11.54K 1/4% .15W

C1 .05 — C2 100 — R3 150K — R6 1K — R10 470

R2 1K — C4 .05 — C5 100 — R7 100 — C8 .05 — R9 220 — C12 15 — R14 100 — Q3 2N3906

R13 6.8K

C6 180 pf — C7 33pf — C9 9-35pf

R4 150K — Q1 3N140 — Q2 2N4121

C3 .05 — R5 100K — R8 680

R11 10

C10 100 — C11 .05 — R12 220

FIRST L.O. J2004-11 5.6-8.7 MHZ — 11

12

5

TB1-2 — 1

S1001-A4 — 9

L2 330 — L3 330 — L4 330

C17 .05 — C18 .01

-10V — 16

C19 .01 — C20 .05 — C21 100 — R23 150K — R26 1K — R30 470 — R33 5.6K — R37 75 1% 1/8W

C24 100 — R27 100 — C27 .05

S2003-K5 — 15

CR7 1N3064 — CR8 1N3064

R21 11.54K 1/4% .15W

R22 1K — C23 .05 — C31 15 — R34 100 — Q7 2N3904

R24 150K — C25 180pf — C26 33pf — R29 500 3/4W ±10% — C32 .05 — R35 5K 3/4W 10% — R38 100 — C33 9-35 pf

C28 9-35pf

Q5 3N140 — Q6 2N4121

14

C22 .05 — R25 100K — R28 680 — R31 10 — R36 3.3K

C29 100 — C30 .05 — R32 220

RF AMPLIFIER 2 — SUMMING AMPLIFIER

T1 — C13 5pf — C14 .8-12pf

CR3 HPA2800 — CR5 HPA2800 — CR4 HPA2800 — CR6 HPA2800

R15 51.1 1/8W ±1% — R16 51.1 1/8W ±1% — R17 100 3/4W 10%

R18 301 1/8W ±1%

T2 — T3

C15 .01 — Q4 LS4416 — R20 3.3K

R19 1.8K — C16 .01

L1 330

C34 100

LOW PASS FILTER

C38 22pf — C42 200pf — C47 120pf

C39 9-35pf — C43 9-35pf — C48 9-35pf

L6 4.6 — L8 4.1 — L10 3.9

C35 18pf — C36 560pf — C40 1000 pf — C44 120 pf — C49 820 pf — C52 470 pf — C54 15pf

C50 12pf

C41 3.3pf — C46 3.3pf — C53 3.3pf — C56 3.3pf — C59 12pf

L5 16-17 — C37 36pf — L7 16-17 — C45 36pf — L9 16-17 — C51 36pf — L11 16-17 — C55 36pf — L12 16-17 — C58 33pf

C60 .01 — R41 22k — R43 1.5K

Q8 3N140 — Q9 2N4275

C57 .05 — R39 3.3K — R40 10K — R42 270 — C61 .01 — C63 .002 — R44 390

C62 .01

P/O P1/J2001

C64 .01 — R45 75 — 7 — 6 — J2005-10 5.50-5.61 MHZ

BANDPASS FILTER — FIRST IF AMPLIFIER 2

NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

CIRCUIT REFERENCE SERIES: 2100

CIRCUIT REFERENCE USED:

C(2I0) I - C(2I) 64	Q(2I0) I - Q(2I0) 9
CR(2I0) I - CR(2I0) 8	R(2I0) I - R(2I) 45
DS( ) - DS( )	S( ) - S( )
F( ) - F( )	T(2I0) I - T(2I0) 3
IC( ) - IC( )	Y( ) - Y( )
L(2I0) I - L(2I) 12	

CUSHMAN ELECTRONICS, INC.

SCALE: — APPROVED BY: — DRAWN BY: C.R

DATE: 12-23-70 — 12-23-70 — REVISED

FIRST R F PC BOARD ASSY 7001 - 0073

24-2100 — DRAWING NUMBER 3524171

2100

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

SECOND IF AMPLIFIER 2 — METER AMPLIFIER — METER DETECTOR — SECOND IF AMPLIFIER 3

P1/J2002

SECOND IF
S2001-A6
455 KHz

T81-2

S2005-9

S2005-8

-10V

R2 68K, L1 50, C3 2700pf, R8 47K, R10 5.6K, C6 0.1, R13 3.3K, R15 1K, C9 0.1, C10 0.1, R19 220, Q3 2N3639, R17 220, C4 .05, Q2 2N3565, C1 0.1, Q1 2N3565, C8 .05, CR1, CR2, HPA2800, R9 12K, R11 560, R14 5.6K, R1 600 .5% .15W, R4 100, R5 1K 3 Adj 10 Turns R6 560, C5 0.1, R3 22K, R12 1.8K, C7 0.1, R16 5.6 *, C11 0.1, C12 0.1, C2 0.1, R7 220, R18 180

C14 .05

R22 220, R20 47K, R23 390, IC1 CA3026, R26 12K, R27 47K, C15 .05, R28 47K, R21 47K, R24 56K, R25 1K

C13 .05

R29 33K, C18 .05, R31 33K, R34 12K, R35 10K, L3 50, C20 2700pf, R41 39, R45 8.2K, C28 .05, R50 68K, R42 1.2K, Q5 2N3565, Q7 2N3565, R37 10K, CR3 1N3064, C22 2700pf, Y1 457.0 KHz, Q6 2N3565, C21 1.0, R38 56K, C24 1.0, Q4 2N4121, Y2 453.0 KHz, P/O IC1 CA3026

R30 33K, R32 33K, R33 560, R36 2.7K, R39 47K, R40 100, R43 6.8K, R46 2.7K, R48 2.7K, R51 15K, C23 2700pf, R44 560, C26 .05, C29 .05, R47 560, C25 .05, C27 .05, R49 220

L2 1000, C16 .01, C17 100, C19 1.0

R57 1K, R56 5.6K, Q9 2N3565, Q11 2N3053, C30 15, C31 25, CR4 1N3064, CR5 1N3064, R58 560, CR6 1N3064, C35 100, R52 560, R53 15K, Q8 2N3565, Q10 2N4121, Q12 2N3053, C33 2700 pf, R54 4.7K, R55 1K, C32 15, R59 560, C34 50, R60 100

RECORDER
9 — J3001
11 — S1001-B8
6 — R2001
3 — J1004/LS2001
2
4 — J2004-4 -12V
17 — R2001
18 — P1-1
P/O P1/J2002

PRODUCT DETECTOR — AM DETECTOR — CARRIER REINSERTION OSC. — AUDIO AMPLIFIER

NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

CIRCUIT REFERENCE SERIES: 2200

CIRCUIT REFERENCE USED:	
C(2201) / - C(2285)	Q(2201) / - Q(2212)
CR(2201) / - CR(2206)	R(2201) / - R(2260)
DS( ) - DS( )	S( ) - S( )
F( ) - F( )	T( ) - T( )
IC(2201) / - IC( )	Y(2201) / - Y(2202)
L(2201) / - L(2203)	

CUSHMAN ELECTRONICS, INC.

SCALE:	APPROVED BY:	DRAWN BY C.R.
DATE: 12-22-70	C.J. Smith 12-29-70	REVISED

AUDIO/METER AMPLIFIER PC BOARD
ASSY 7001-0075

24-2200 | DRAWING NUMBER 3524173

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
1	EC-48	4-20-71	

SAMPLING BRIDGE — HARMONIC GENERATOR — DRIVER — 100 KHZ XTLO — CALIBRATION LEVEL AMPLIFIER

J2004-14
5-6-8.7 MHZ

P1/J2003

P/O P1/J2003

-10 V

CR1 HPA 2800
CR2 1N3064
CR3
CR4 HPA 2800
CR5 HPA 2800
CR6 HPA 2800
CR7 1N3064

IC1 CA3026
P/O IC1 CA3026

Q1 2N4275
Q2 2N4121
Q3 2N4275
Q4 2N3565
Q5 2N3565
Q6 2N4275
Q7 2N4275
Q8 2N4275
Q9 2N4275
Q10 2N4121

T1
T2

Y1 100KHZ

L1 1000

R1 8.2K
R2 8.2K
R3 10K
R4 820K
R5 100
R6 270
R7 270
R8 100
R9 220
R10 47K
R11 12K
R12 47K
R13 10K
R14 56K
R15 8.2K
R16 12K
R17 1K
R18 3.9K
R19 1.5K
R20 22K
R21 22K
R22 2.2K
R23 560
R24 2.2K
R25 3.3K
R26 2.2K
R27 22K
R28 22K
R29 1K
R30 39
R31 22
R32 100 3/4W 10%
R33 6.8K
R34 100
R35 18K
R36 10K
R37 22K
R38 10K
R39 1.5K
R40 100K 1/2W 10%
R41 18K
R42 560
R43 100
R44 1.8K
R45 5.6K
R46 47K
R47 5.6K
R48 1.5K
R49 10K
R50 10K 3/4W 10%
R51 3.9K
R52 18K
R53 1K
R54 6.8K
R55 47K
R56 220

C1 1000pf
C2 68pf
C3 68pf
C4 75pf
C5 2.2pf
C6 1.0
C7 150pf
C8 .01
C9 27pf
C10 27pf
C11 9-35pf
C12 .01
C13 1.0
C14 1.0
C15 .01
C16 .05
C17 15
C18 1.0
C19 3.3
C20 .01
C21 1.0
C22 1.0
C23 .01
C24 .05
C25 .01
C26 1.0
C27 .05
C28 47pf
C29 39pf
C30 1.0

2N3819

5 → S1001-B5
6
1
16
18 → WT1 → P1-6
7 → S1001-A3
15 → S1002-5
14 → S1002-2
16

SCHMITT TRIGGER — DC AMPLIFIER — ERROR SIG. AMPL

NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

CIRCUIT REFERENCE SERIES: 2300

CIRCUIT REFERENCE USED:	
C(230)1 - C(23)30	Q(230)1 - Q(23)11
CR(230)1 - CR(230)7	R(230)1 - R(23)56
DS( ) - DS( )	S( ) - S( )
F( ) - F( )	T(230)1 - T(230)2
IC(230)1 - IC( )	Y(230)1 - Y( )
L(230)1 - L( )	

CUSHMAN ELECTRONICS, INC.

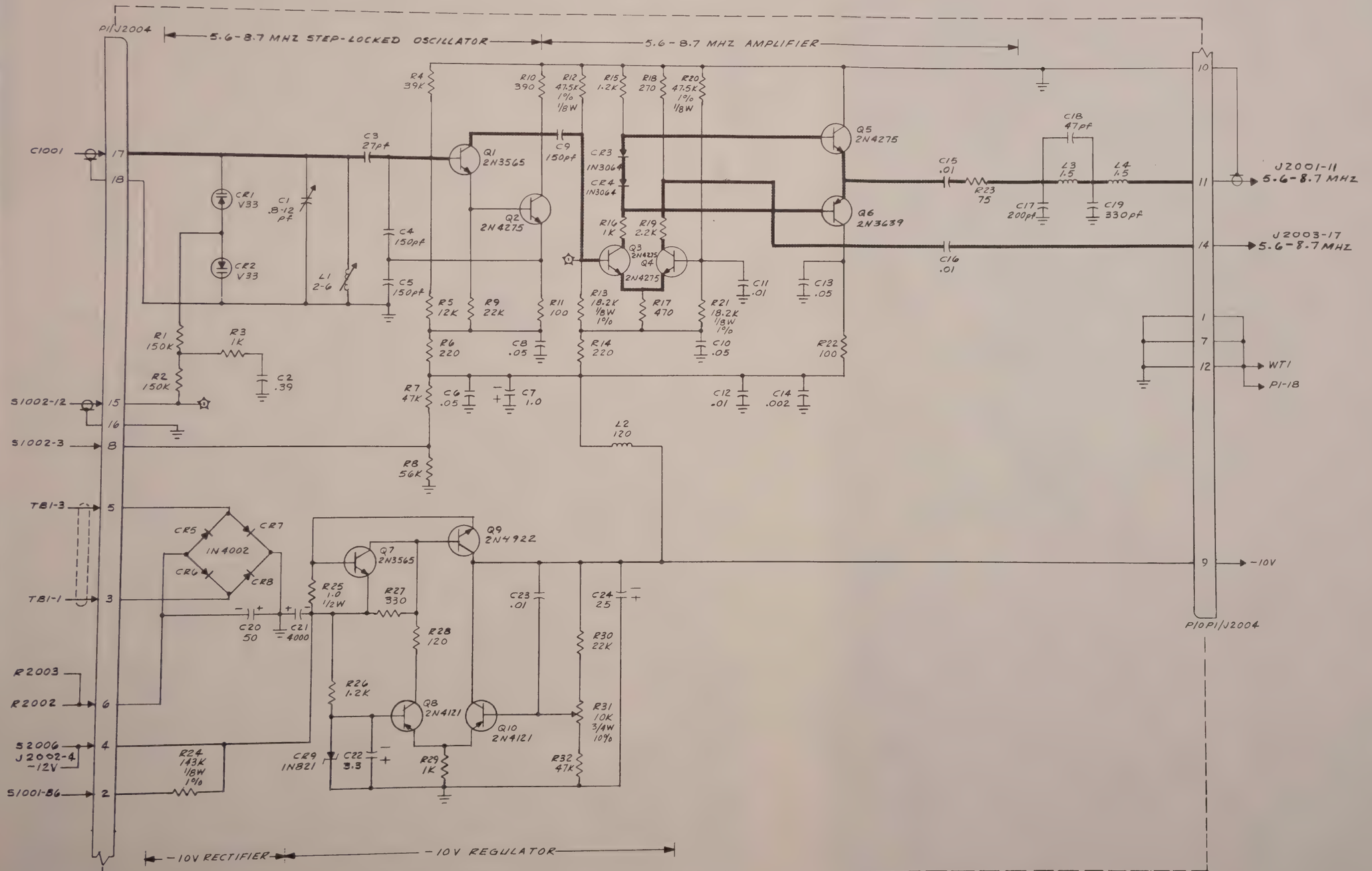
SCALE	APPROVED BY:	DRAWN BY C.E.
DATE: 12-21-70	12-29-70	REVISED

100 KHZ PHASE LOCK PC BOARD ASSY
7001-0077

24-2300 — DRAWING NUMBER 3524176

2300

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	EC-55	7-22-71	7-23-71



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

CIRCUIT REFERENCE SERIES: 2400

CIRCUIT REFERENCE USED:	
C(2401) - C(24)24	Q(2401) - Q(24)10
CR(2401) - CR(24)09	R(2401) - R(24)32
DS( ) - DS( )	S( ) - S( )
F( ) - F( )	T( ) - T( )
IC( ) - IC( )	Y( ) - Y( )
L(2401) - L(24)04	

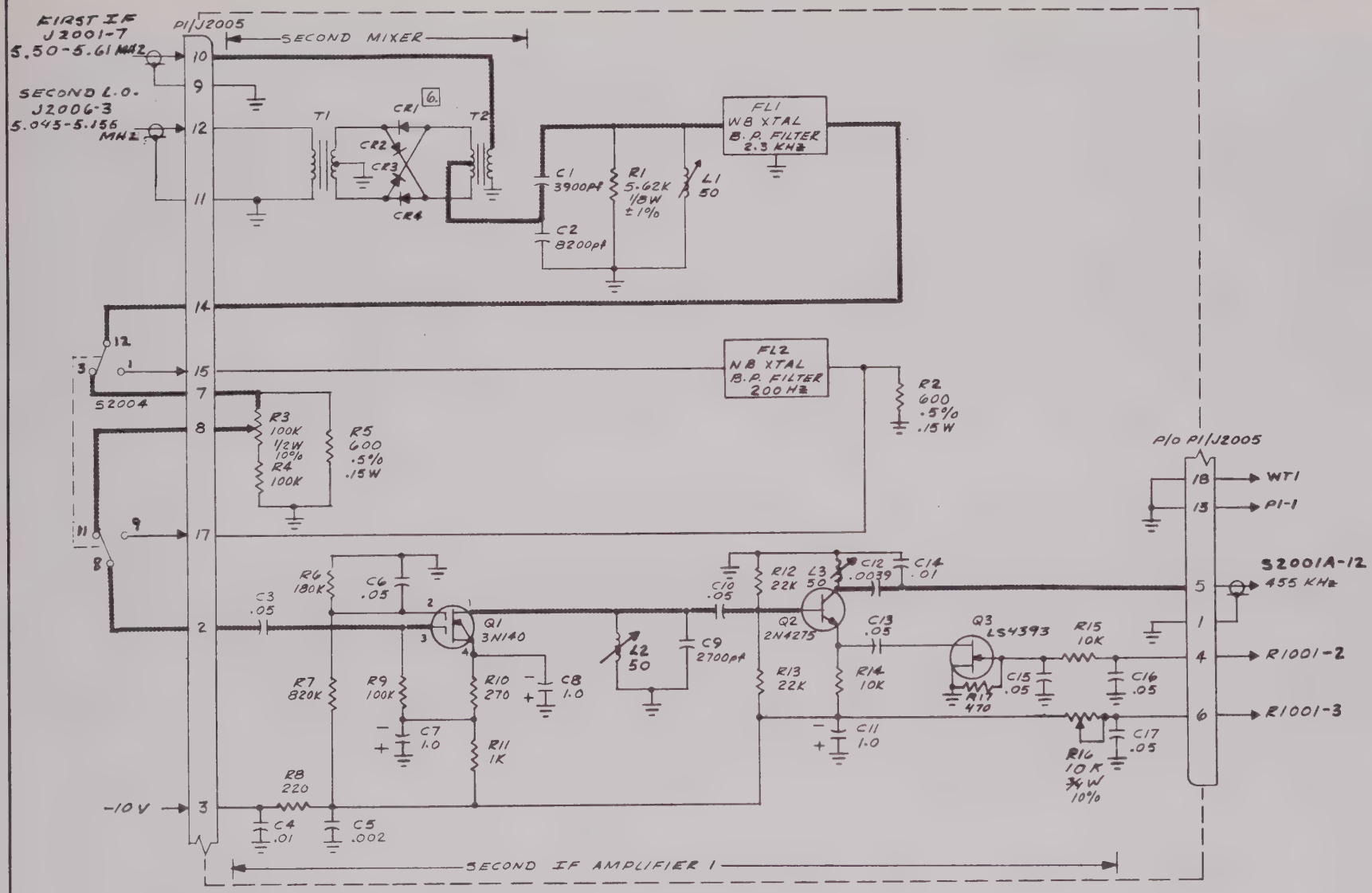
CUSHMAN ELECTRONICS, INC.

SCALE:	APPROVED BY:	DRAWN BY C.R
DATE: 12-24-70	12-29-70	REVISED

VCO/POWER SUPPLY PC BOARD ASSY 7001-0078

24-2400 | DRAWING NUMBER 3524177

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	EC-56	7-22-71	7-23-71



NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. DIODES – HPA2800.

CIRCUIT REFERENCE SERIES: 2500

CIRCUIT REFERENCE USED:	
C(250)1 – C(25)17	Q(250)1 – Q(250)3
CR(250)1 – CR(250)4	R(250)1 – R(25)17
DS( ) – DS( )	S( ) – S( )
F( ) – F( )	T(250)1 – T(250)2
IC( ) – IC( )	Y( ) – Y( )
L(250)1 – L(250)3	FL(250)1 – FL(250)2

CUSHMAN ELECTRONICS, INC.

SCALE:	APPROVED BY:	DRAWN BY C.R.
DATE 12-18-70	12-29-70	REVISED

SECOND IF PC BOARD ASSY 7001-0076

24-2500

DRAWING NUMBER 3524174

2500

17350 PRINTED ON RO 1000H 10 CLEARPRINT

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	EC-67 & EC-75	10-7-71	

545-655 KHz OSCILLATOR | LOW-PASS FILTER | 2ND LO MIXER | 5.045-5.155 MHz BANDPASS FILTER | SECOND LO AMPLIFIER

P1/J2006

C1002 — 14
13
R1002-2 — 17
R1002-3 — 16
S2005-11 — 15
-10V — 7

C1 36pF, C5 0.8-12pF, L1 360-600, C10 360pF, C11 620pF, R4 47K, R5 12K, R6 100K, R7 1K, R8 5.6K, R9 1.2K, C9 47pF, C18 .05

Q1 2N5089, Q2 2N5089

C20 68pF, L4 82, L5 82, R14 220, C21 680pF, C22 1500pF, C23 680

CR2 HPA2800, CR3 HPA2800, T1

C28 470pF, C29 18pF, C30 470pF, C31 18pF, C32 470pF, C33 18pF, C34 470pF, C35 0.1, L7 2.55, L8 2.55, L9 2.55, L10 2.55

R2 100K, R3 100K, C2 .05, C6 .05, CR1 V33, C12 1000pF, C13 5pF, C14 0.8-12pF, R1 22K, Y1 5.7 MHz, C17 .01

R10 82K, L6 4.1, C26 150pF, C27 27pF, Q3 2N4275, R11 12K, C24 150pF, C25 620pF, R12 1.2K, R13 1K, C19 .05

L2 100, C3 .01, C7 .05, C15 .05

C4 .01

5.7 MHz VCXO

L3 100, C8 .05, C16 .05

R15 22K, Q4 2N4275, R17 1K, R19 8.2K, C36 0.1, C37 0.1, C38 .01, IC1 CA3028A, C39 0.1, C40 33pF, C41, R16 68K, R18 3.3K, R20 10K, R21 2.7K, L11 20

R25 33K, C46 .01, L12 1000, C42 15, R22 3.9K, C47 .01, R26 1.5K, C54 0.1, C43 .01, R23 3K, R24 4.7K, IC2 CA3028A, R28 680, L13 180, L14 180, C51 10, C50 200pF, C52 470pF, C53 200pF, R29 680, C44 680pF, C45 22pF, C48 0.8-12pF, Y2 5.145MHz, R27 680, C49 680pF

P1/J2006 — 11, 2, 6, 1, 5, 18, 8, 12, 3, 4, 10, 9

WT1

J2005-12 SECOND LO 5.045-5.155 MHz

J3003 KHz SIG. OUT

NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

CIRCUIT REFERENCE SERIES: 2600

CIRCUIT REFERENCE USED:	
C(260)1 - C(26)34	Q(260)1 - Q(260)4
CR(260)1 - CR(260)3	R(260)1 - R(26)29
DS( ) - DS( )	S( ) - S( )
F( ) - F( )	T(260)1 - T( )
IC(260)2 - IC( )	Y(260)2 - Y( )
L(260)1 - L(26)14	

CUSHMAN ELECTRONICS, INC.

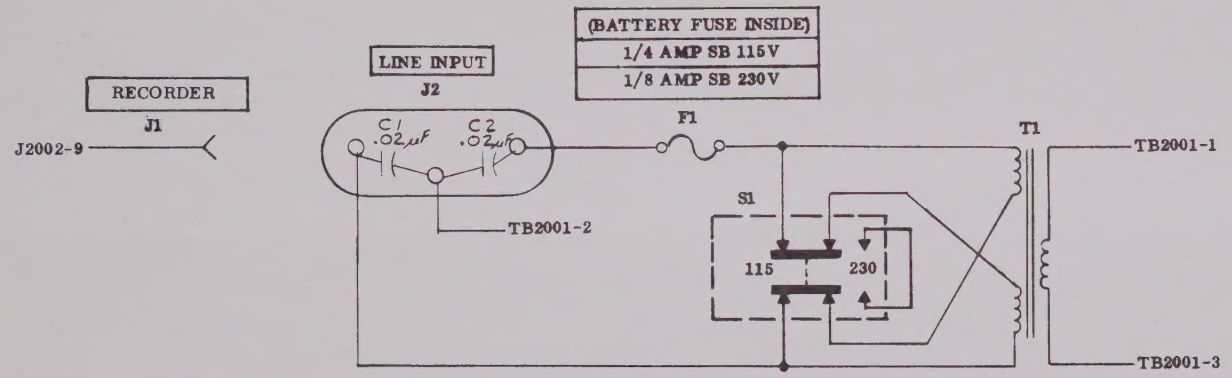
SCALE:	APPROVED BY:	DRAWN BY: LLD
DATE: 10-7-71	10-8-71	REVISED

SECOND LO/BFO PC BOARD ASSY 7001-0136

EFF SER NO 341 & UP — 24-2600 — DRAWING NUMBER 3524167

SIZE D4 PRINTED ON ISO. 1:000N - 10 CLEARPRINT

	REVISIONS		
LTR	DESCRIPTION	DATE	APPROVED



CIRCUIT REFERENCE SERIES: 3000

CIRCUIT REFERENCE USED:	
C(300)1 - C(300)2	Q( ) - Q( )
CR( ) - CR( )	R( ) - R( )
DS( ) - DS( )	S(300)1 - S( )
F(300)1 - F( )	T(300)1 - T( )
IC( ) - IC( )	Y( ) - Y( )
L( ) - L( )	

CUSHMAN ELECTRONICS, INC.

SCALE:	APPROVED BY:	DRAWN BY C.R.
DATE: 12-17-70	J.F. Smith 12-29-70	REVISED

REAR PANEL WIRING DIAGRAM

24-3000

DRAWING NUMBER 3524003

3000

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